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THE YANGTSZE KIANG AT HANKOW.

THE great inland maritime and commercial port of China is situated on the river Yangtsze Kiang, nearly six hundred miles from the open sea, in a position something like that of Montreal with regard to the navigation of the river St. Lawrence. It may be anticipated that, by the proposed construction of a railway from Pekin due south to Hankow, which has recently been decreed by the Emperor of China, the importance of Hankow, as the most central mart of foreign traffic accessible to seagoing ships of all nations, will be vastly increased. We present a view of the place, by Mr. William Simpson. He tells us that "Hankow means the Han mouth, and is at the junction of the Han with the Yangtsze. There are three distinct towns at the place. The principal one, Wuchang, the capital of the province of Hupeh, is on the south side of the river; Han-yang and Hankow, which are separated from each other by the Han River, are on the north bank (of the Yangtsze Kiang). The settlement where the Europeans have their houses is in the eastern part of the town. A magnificent bund, or embankment, has been constructed, and along this is a wide thoroughfare, with trees along it, reminding one of a boulevard. Facing this, and overlooking the broad expanse of the Yangtsze, are the residences—and it is no stretching of the word to call them palatial—of the Europeans. The rising of the river in summer, which reaches a great height, renders this great bund necessary. High and dry as it is, the river often covers it and the whole country round. When this occurs, the residents here have to go from house to house in boats; even the communication with the kitchen, which is generally an outhouse, has to be kept up in this way.—*Illustrated London News.*

THE NEW CHINESE RAILWAY FROM PEKIN TO HANKOW—VIEW OF THE YANGTSZE KIANG AT HANKOW.

[AMERICAN NATURALIST.]

FROM BRUTE TO MAN.

By CHARLES MORRIS.

THAT man as an animal is an offspring of the lower life kingdom, none who are familiar with the facts of science now think of denying. Despite the indignant protest against this idea when promulgated by Darwin less than thirty years ago, it is now generally accepted by all those who have fully considered the evidence, and who therefore are alone competent to decide upon it. But that man as a thinking being has descended from the lower animals is a very different matter, and is by no means proved. Regarding the origin of man's intellect, there is much difference of opinion, even among scientists, and such a radical evolutionist as Alfred Russel Wallace finds here a yawning gap in the line of descent, and believes that the intellect of man is a direct gift from the realm of spirits. His explanation, it is true, is more difficult than the difficulty itself. It cannot justly be called a hypothesis, for a hypothesis should have some facts to give it warrant, and this has none.

That man's mind cannot be explained on the principle of natural selection, we may, with Wallace, admit. But it certainly would have been better had he on his part more fully considered the possibilities of use and effort, and other natural agencies, before dragging in the angels to bridge the chasm.

That man's intellect at its lowest level is not different in kind from the brute intellect at its highest level, Romanes has satisfactorily shown. His evidence, indeed, is superabundant. Known facts that bear upon the question are stubborn things to explain on the evolution theory.

If, for instance, we examine the existing conditions of ape and savage intellect, no evidence of any active evolution can be discovered. However the anthropoid apes gained their mental acuteness, there is nothing to show that it is increasing.

The same may be said of the lowest savages. They are mentally stagnant. The indications are that their intellectual progress for thousands of years in the past has been almost nothing. Yet if man is the descendant of an anthropoid ape, there must have been an extraordinary degree of mental development between the one state and the other to produce the great increase in size of brain and activity of intellect. Under the present conditions of imperceptible progress, the whole tertiary period of geology, and perhaps much of the secondary period, would be needed to fill the gap. Yet no such extensive interval can be admitted, and if we seek to deduce man's mind from the ape mind, we must be able to show that influences existed calculated to produce a much more rapid mental evolution than now can be perceived in either ape or savage.

Controversy on this subject is too apt to be based on the difference between the intellect of the brute and that of enlightened man. Yet the mental gap between the latter and the lowest savage is quite as great as that between the savage and the brute. From the intellect of the animal to that of enlightened man the distance is enormous, yet throughout its whole extent, with a single exception, can be traced intermediate steps of mental development.

This exception is the interval between the anthropoid ape and the primitive savage. This is the only gap that remains open in the kingdom of the mind—the one important lost chapter from the story of mental evolution.

It is acknowledged by every well informed scientist that man's body came up from below. Its links of association with the lower animals are too many and too significant to admit of any other theory. Supernaturalism, therefore, has taken its last stand upon man's mind, and claims that here at least the line of descent is a broken one, and that the gap could not have been filled without a direct interposition from the realm of spirit.

This view of the case is not likely to be accepted as final. Science has bridged with facts so many chasms in the kingdom of nature, that it will scarcely be ready to admit, certainly not till the case has been more thoroughly investigated, that here is a chasm which cannot be bridged, and must be leaped. And yet the lated to produce a much more rapid mental evolution than now can be perceived in either ape or savage.

Man has changed but little physically since he became man, and perhaps changed little during the period in which he was becoming man. Could we behold the species of ape which, in the opinion of evolutionists, was his ancestor, we should probably be able to discover no important differences in form. The change has been in the brain, not in the body. The transforming influences acted upon the organ of the mind, not upon the organs of physical life. The brain has yielded to these forces, not by varying in form, but by increasing in size, and by a special expansion of that portion of it devoted to intellectual activity.

This great increase in the size of the brain, with the accompanying remarkable unfoldment of the mental powers, certainly indicated the action of very vigorous and long-continued transforming influences; which, if we may judge from the mental stagnation of the present ape and savage, no longer exist.

It is true that the mental organism may be far more plastic than the body, and that no time relations between the development of the intellect and of the physical structure can be drawn.

Transformation, under influences of equal potency, may possibly be produced more rapidly in the one case than in the other. An extraordinary development has taken place in the human intellect within a few thousands or tens of thousands of years, yielding the differ-

ence that now exists between the cultivated European and the debased savage, and which perhaps equals that between the latter and the ape.

If, therefore, it can be shown that influences were at work upon original man as powerful as those that have produced civilization, we shall have done something toward showing how the ape brain may, in a comparatively limited period, have become the brain of man.

The leading causes of the development of civilized man are not at all difficult to discover. Undoubtedly the most potent among them was the influence of warfare, the struggle between man and man on the one hand, and between man and the conditions of soil and climate in the colder latitudes on the other hand. More recently competition in commerce and industry has taken the place of the warlike struggle for existence, and the contest for wealth and position is continuing the effect which the contest for life produced. Hostility between man and nature, and between man and man, has for ages been invigorating the human intellect, replacing the dull of brain and slow of thought by the quick-witted, energetic, and intelligent, and we may safely look upon this as the most active agent in the unfoldment of civilization.

Was the development from ape to human intellect due to a similar conflict?

In the tropics, the home of the savage, war between man and nature scarcely exists, and war between man and man is in its primitive stage. Yet here, as elsewhere, it has much to do with such mental unfoldment as exists.

Mastery in warfare is due to superior mental resources, which are gradually gained through the exigences of conflict, and are shown in greater shrewdness or cunning, superior ability in leadership, and the invention of more destructive weapons.

War acts vigorously on men's minds, peace acts sluggishly; and the whole story of mankind tells us that intellectual evolution has been due in great part to the destruction in war of the mentally weaker, the preservation of the more energetic and able, and the effect of conflict in producing intellectual activity. But no organized warfare or alert conflict with nature can be perceived in the lowest existing savages.

This powerful agent of intellectual development is certainly not at present exerting much influence upon them; they accept the world as they find it, without question or revolt, and their thoughts and habits are as unchangeable as the laws of the Medes and Persians.

But that this stagnancy has always prevailed may well be doubted. The position of the savage is to-day very different from what it was ten or twenty thousand years ago. Then he was dominant upon the earth, the undisputed lord of the kingdom of life.

Now new lords of life have come, who are pressing in upon him on every side, preventing his expansion, hampering his activities, and gradually crowding him off the earth.

What powers of development primitive man may have possessed can hardly, therefore, be determined from a study of the existing savage, and to gain any solution of the problem we must consider the position of primitive man.

As we have said, the lower savages and the anthropoid apes are at present alike mentally stagnant, while the mental interval between them is very great. But primitive man differed from the lower animals in one important particular. He was lord and master of the animal kingdom, the dominant being in the world of life. He had no rival in this lordship. None of the herbivora, and none of the carnivora, in any full sense, have ever possessed a similar mastery. The large carnivora are dominant only over the weaker herbivora.

So far as we know, the only animal which, except in self-defense, will assail the large carnivora, is the gorilla. This powerful ape is the only creature, except man, of which the lion seems afraid. It does not attack it, however, from any desire for mastery, but simply to drive away a dangerous neighbor.

Man stands alone in his relation to the lower animals. He is lord of them all. Savages everywhere are aggressive against, and are feared and avoided by, the largest and strongest beasts of their region. This hostility does not come from the wish to drive away an enemy. It is the desire for food or the instinct of control that moves the savage hunter. He feels, and prides himself on, his lordship. Man does not fight defensively, like the gorilla, but offensively, and whatever be his position in relation to his fellow man, he admits no equal in the world below him.

This lordship was not gained without a struggle, and that a severe and protracted one. The animal kingdom did not submit supinely to man's mastery. The war must have been long and bitter, however fixed and settled the relations now seem. Rest has followed victory. The animal world is now submissive to man, or in dread of his strength and resources, and the strain upon his mental powers has ceased. But there is certainly reason to believe that men's intellectual progress was due to warlike struggles alike in the primitive and in the historic epoch, the former being a conflict with animals, the latter with man.

We cannot describe at length this primitive hostility. It will suffice to say that it must have been attended with a somewhat rapid mental progress, probably greatly in excess of that which we now perceive in apes and lower man. For the battle was fought with the mind, not with the body. That is to say, man did not depend on hereditary instincts and his natural weapons of claws and teeth for victory, but brought his mental resources into play. Cunning, caution, boldness where necessary, close observation, variation in modes of attack and defense to suit varying circumstances, are hostile methods of purely mental origin. They are not peculiar to man; many of the lower animals employ them, though none to such an extent as man. But the use of other than the natural weapons is nearly peculiar to man. Some of the monkeys occasionally and imperfectly employ missiles, but man alone has become aware of their great utility, and employs them constantly and skillfully. By the use of artificial implements of warfare his powers were enormously increased and the steps of progress in his subordination of the lower animals were doubtless marked out by his invention of more and more efficient weapons.

We take it for granted that the animal world did not submit without a struggle, and a protracted one. Step by step, through many centuries of conflict, were the larger animals subdued. It was man's mind, not his body, that subdued them. Physically they were his equals or superiors. His superiority lay in his mental resources, and his victory was due solely to his mental superiority. The effect of the conflict therefore bore principally upon his mind, and its organ, the brain, very little upon the body; and when we consider the extent of the achievement, we cannot be surprised at the result. Such an advantage, if gained by any of the lower animals through variation of physical structure alone, could not but have produced radical and extraordinary changes in size, strength, and utility of natural weapons. In man the influences of variation were exerted upon the brain alone, and the decided increase in size and activity of this organ does not seem too great for the magnitude of the result. The conflict ended, man settled down to quiet consciousness of victory, but with a much larger brain and greatly superior mental powers than at the beginning of the struggle. This brain and the higher mentality it indicated enabled him to hold the position he had gained, but there was no special further strain upon his powers, and he simply held his own until a new era of war, now between man and man, or between man and cold and stubborn nature, called again upon the resources of the mind, and a new era of intellectual evolution began. It is quite possible, as we have said, that the strain in the former case was equal to that in the latter.

Not every animal is adapted by nature to such an evolution. Nearly every animal would be prevented from it by physical disadvantages. Even the anthropoid apes lack certain essential conditions of structure and habits, though favored by the formation of their hands and their power of grasping and using weapons. But of all animals, the species from which man descended seems to have been the best adapted, and far the most likely, to become the ancestor of a thinking being. For the mental evolution of man was due not only to his struggle for mastery, but also to special advantages which he possessed in the physical structure and the social relations of his ape ancestor. Let us consider the former of these. We know that the ape family are fruit eaters, and that trees are their natural habitat. But the larger apes manifest an inclination to descend to the earth, probably from their weight rendering a continual life in trees none too agreeable. The largest of them, the gorilla, dwells almost normally on the ground, and it is quite probable that this was the case with man's ancestor. On the ground apes have to make certain changes in their method of locomotion. In the trees they move in a quadrupedal or in a semi-bipedal attitude, by crawling along the limbs, or by walking along the lower and clasping higher limbs with their hands. On the ground either a quadrupedal, a bipedal, or an intermediate motion must be assumed. The baboons, whose fore and hind limbs are nearly equal in length, have become quadrupeds. The three principal species of anthropoid apes, in each of which the fore limbs are of considerable length, have adopted an intermediate mode of motion, swinging their bodies between their hands. The gibbon alone walks in an erect attitude, its very long arms enabling it to use its hands in walking without bending its body. All these animals are essentially quadrupeds, inasmuch as they use all four limbs in locomotion. The gibbon alone is somewhat inclined to walk as a biped, but not when moving swiftly.

Man is structurally different from all these. His arms are shorter as compared with his legs than in any of the existing large apes. It would be impossible for him to walk in the swinging manner of these apes, or by aiding himself with his hands like the gibbon. Quadrupedal motion on hands and feet would be almost equally difficult for him. If his ancestor was like him in this respect, as was undoubtedly the case, then on descending to the ground it must have been forced to walk on its feet alone, from the much greater difficulty, if not the impossibility, of the other modes of motion.

If man's ancestor, however, became a biped through this necessity, it at once assumed a position of remarkable advantage, becoming the only species among the higher animals that did not have to use all four of its limbs in locomotion. His arms and hands were freed for other purposes, and the grasping powers of the hands added immensely to the advantages which this gave. In fact, there can be no question that man owes his supremacy in the animal world to the possession of two limbs which were free from duty as walking organs and could be used fully for attack and defense, and to the grasping power of his hands, which rendered easy and natural the employment of weapons.

To this must be added the mental development which all known anthropoid apes possess. These marked advantages at once changed his relation to the lower world of animals. Flight was no longer necessary to safety. He was able to meet much larger animals on equal ground. He was already, like all the apes, mentally acute, observing, and capable of foreseeing and providing for contingencies. As his power of walking erect became easy and natural, and the adaptation of his arms and hands to the use of weapons grew more definite, his standing in the animal kingdom essentially changed; fear and flight ended, so far as animal foes were concerned, retreat ceased, attack began, his mental acumen was called into active play, and the great battle for mastery of which we have spoken came fully into play.

Still another essential element in this development was the social habit of man's ancestor. If we may judge from the conditions of existing savages, the man-ape was a more social animal than any of the existing anthropoids. The orang and the gorilla are not sociable to any important extent. The chimpanzee is somewhat more so. The indications are that man's ancestor was social in a higher sense than any of these, and employed the principle of mutual aid in a greater degree. It is scarcely necessary to speak of the advantage this would give in the struggle with animals. This advantage is patent. But there is one important result of close social relations of the utmost importance in this connection—that of education. All social animals educate one another, either with or without design. Anything of importance learned by one member of the group is quickly imparted to all members, and the more rapidly the better the methods of communication and the more complete their system of mutual aid. The lower monkeys teach their young, and indicate to one another anything of importance. There is no doubt that any new and useful weapon or method of assault or defense devised by any member of such a group would become quickly and permanently the property of all the members, and would constitute an important aid in mental development. A long succession in such ideas or inventions, gained by single bright members of evolving mankind, and taught to the others, must have played a highly useful part in the progress from apehood to manhood.

Socialism has been an important requisite of mental evolution throughout the animal kingdom. The highly social ants and bees have raised themselves mentally far beyond all the other insects. The social beavers show a remarkable mental ability as compared with the other rodents. It is, indeed, the communal rather than the simply social animals that have made these great steps of mental progress, those whose labor is devoted solely to the good of the community, and who work in concert for the advantage of each and all. To what extent man was communal in his developing stage it is impossible to say, but the general communism of barbarism may well have been an outgrowth of a primitive condition. There is reason to believe that the individualism which now prevails is of late origin, and was not a characteristic of original man.

One further agency was necessary to man's development—that he should become carnivorous. The apes are fruit eaters, and lack the native fierceness and the aggressive disposition of the flesh-eating animals. Doubtless man's ancestor was a fruit eater, but new habits of life probably accustomed him to a mixed fruit and flesh diet at an early period, and the quest of animals for food must have led him to wider excursions and more active enterprise than in the case of any of his frugivorous kindred. Here was an agency calculated to bring him into new scenes and novel relations to nature, and thus greatly to increase the strain upon his faculties and the consequent activity of his mind.

If man came from the ape, it seems certainly very probable that these were the channels of his coming, these the adaptations, the methods, and the exigences through which a frugivorous ape became an omnivorous man, with a brain like that of the ape in form, but greatly developed in size, and faculties like those of the ape in quality, but immensely developed in width and height. From being the equal of the animals he became lord of the animals, their peer perhaps in body, their monarch in mind.*

THE USE OF HYDROCYANIC ACID GAS FOR THE DESTRUCTION OF THE RED SCALE.

By D. W. Coquillett, Los Angeles, Cal.

In accordance with a written request from several of the orange growers of Orange, I went down to that place in the latter part of September of the present year, and conducted a series of experiments with hydrocyanic acid gas for destroying the red scale, with the view of trying to discover some simpler and less expensive method of producing and manipulating this gas than the one heretofore in use. The lemon trees experimented upon and also the fumigating outfit used in making these tests were kindly placed at my disposal by their owner, Mr. A. D. Bishop; and the latter gentleman, in conjunction with Mr. A. H. Alward, also aided me in moving the outfit from tree to tree when making the tests. Among the different methods tried was one that gave very satisfactory results, and which, both in regard to expense and labor, is a great improvement upon any heretofore tried. It consists in using one part by weight of dry or undissolved potassium cyanide with one part sulphuric acid and two parts of water. The generator is made of lead and is somewhat in the form of a common water pail. After the tent is placed over the tree the necessary quantity of the dry cyanide is placed in the generator, the proper quantity of cold water added, and the generator placed under the tent near the trunk of the tree; the acid is then added to the materials in the generator, a barley sack thrown over the top of the latter, after which the operator withdraws and a quantity of earth is thrown upon the lower edge of the tent, where it rests upon the ground, to prevent the escape of the gas. After the expiration of fifteen minutes the tent is removed and placed upon another tree. I tested this method on several lemon trees, and found that when the proper quantity of material had been used, neither the foilage nor fruit on the trees were injured, while neither myself nor several other persons were able to find a living red scale upon the trees treated in this way.

The following table, based upon several of the tests referred to above, will aid in determining the proper quantity of each ingredient to use in treating orange and lemon trees:

Height of Tree.	Diameter of Tree.	Cyanide of Potash.	Water.	Sulphuric Acid.
Ft.	Ft.	Oz.	Fl. Oz.	Fl. Oz.
10	8	2¼	4½	2¼
12	10	4½	9	4½
12	14	8¾	17½	8¾
14	10	5½	11	5½
14	12	7½	15	7½
16	14	12	24	12
18	14	15	30	15

It will be noticed that the proportions are 1 oz. by weight of the cyanide to 1 fl. oz. of the acid and 2 fl. oz. of water; or in the proportion of cyanide one, acid one, water two. This being borne in mind, it will be very easy to ascertain how much acid and water to

* The views presented in this paper are not offered as original. The argument from the social habits of man has been advanced by myself in a previous paper in the *Naturalist*, while as for the general subject of the influence of intelligence on human advancement, it has been dealt with by Prof. E. D. Cope in papers entitled "The Method of Creation of Organic Types," "The Hypothesis of Evolution," "The Review of the Modern Doctrine of Evolution," and others which may be found in his work entitled "Origin of the Fittest." The influence of use and effort, as agents in evolution, has been dealt with by various American writers. The doctrine of selection through the struggle for existence, in fact, covers all that has been said above, and the only novelty claimed is the particular application of this doctrine to the struggle of man for dominion over the world of brutes, and the influence of this struggle on the growth of the brain and the development of intelligence. This view, so far as the writer knows, has not been advanced before.

use when once the proper quantity of the cyanide required for treating any given tree has been ascertained.

In making the tests referred to above, I used commercial sulphuric acid and a medium grade of potassium cyanide, manufactured by Powers & Weightman, of Philadelphia, Pa.

At the present prices of the cyanide and acid, the cost of the materials necessary to treat an orange tree of the size given above, by this new method, will amount to about twenty-six cents.

Not only is the new process much cheaper than the old, but it is also attended with much less labor. By using the cyanide dry we are saved the trouble of first dissolving it; the dry cyanide is also easier to transport and safer to handle than the solution is, and if the vessel containing it should be accidentally overturned on the ground, the dry cyanide will not be lost, as it certainly would if dissolved. By thus using the cyanide dry it is not necessary to first pass the gas through sulphuric acid in order to render it harmless to the trees, thereby saving a great deal of labor, and admitting of the use of a much simpler and less expensive generator. By placing the latter beneath the tent there is less liability of the gas escaping while being generated and introduced into the tent from without, thereby also insuring the operator greater immunity from inhaling the gas. I also found that by thus placing the generator under the tent, the blower heretofore used for distributing the gas inside of the tent could be done away with, thereby still further reducing the original cost of a fumigating outfit, besides doing away with the labor necessary in operating the blower. The time during which it is necessary to confine the tree in the gas has also been reduced one-half as compared with that heretofore allowed for destroying the fluted scale (*Icerya purchasi* Maskell), thereby rendering it possible to treat twice the number of trees in a given time that could be treated in the same time by the old process. I found by experiment that about five minutes were consumed each time in generating the gas.

The treatment with hydrocyanic acid gas is the only method known to me whereby the scale insects located upon the fruit can be destroyed by a single operation. My own experience, and that of every other person with whom I have conversed upon this subject and who has had any considerable experience in the matter, indicates that no liquid preparation at present known will by a single application prove fatal to more than ninety per cent. of the number of red scales located upon the fruit; and when it is remembered that the supervisors of many counties in this State have passed laws making it a misdemeanor to sell or expose for sale fruit infested with scale insects, the value of the gas treatment to our fruit growers is made apparent.

The trees operated on were all of them lemon trees containing fruit, and were in a comparatively healthy condition, although very thickly infested with the red scale. Before making these tests, I had the experimental tent painted black, and am strongly of the opinion that when a tent of this color is used, the foliage of the trees will be injured less when by inadvertence an overdose of the materials has been used than would be the case if a light-colored tent were to be used; the light rays, more than the rays of heat, serve to decompose the gas, and on this account any medium that will intercept the rays of light will, in a great measure, prevent the decomposing of the gas.—*Insect Life.*

EXPERIMENTS WITH SPRAYING.

A RECENT bulletin of the Wisconsin Experiment Station, and another from the Connecticut Station, present some interesting results of experiments made with fungicides. Prof. E. S. Goff, of Wisconsin, gives, in addition to notes previously published, a detailed account of a series of tests on the apple scab—a disease which annually destroys or lessens in value the apple crop of the country to the amount of millions. The experiments were more particularly made on the Fameuse, which is well known to be much affected with the scab. Twelve trees of nearly uniform size in an orchard were selected for the experiments. Four different liquids were used—a solution of potassium sulphide, a solution of hyposulphite of soda, a third by slaking lime with a portion of sulphur and mixing with water, and the fourth, and much the best of all, with a solution of an ounce of carbonate of copper in a quart of liquid ammonia, diluted with one hundred parts or more of water.

One tree was left unsprayed for the purpose of comparison. The work was done when the flowers had fallen, and the apples were scarcely larger than peas. The spraying was repeated through June and July and into August, about every fortnight.

All the treatments were more or less beneficial, but that of the carbonate of copper solution *was almost a complete remedy for the disease.* It proved beneficial in such a striking degree that Mr. Hatch, the owner of the orchard in which the experiments were made, has decided to treat his entire twenty-five acre orchard with this application the coming season.

One and one-half gallons of the diluted solution are sufficient to thoroughly spray a tree of medium size. Four ounces of carbonate of copper and one gallon of ammonia are, therefore, enough to make one hundred gallons of the diluted solution, and sufficient to spray seventy-five medium size trees at once. In applying this remedy for the scab, the ammonia, being volatile, should be procured in a glass vessel, and kept corked with a rubber stopper. To this add the precipitated carbonate of copper at the rate of an ounce to a quart of ammonia, which dissolves into a clear blue liquid. For use in spraying, add a quart of this liquid to twenty-five gallons of water. Keep the solution tightly corked. The liquid is applied with a force pump, as is commonly done with Paris green. The number of required applications is not yet determined. London purple and Paris green cannot be used with this solution, as the ammonia renders the arsenic more soluble, and may injure the foliage, but they may be applied a few hours later.

In the bulletin of the Connecticut Station, from Professor R. Thaxter, mycologist, minute directions are given for the adjustment and use of the various appliances in connection with the spraying pumps, which will be of use to the owners of large orchards, and facilitate in doing the work rapidly. The expense of these different parts is given, the cost of materials for the Bordeaux mixtures, etc. The well known objection to the use of this mixture, especially to grapes, on account of its adhesion to them, is proved to be removed by using the carbonate of copper for the last or two last applications, or by treating the injured clusters with highly diluted vinegar—two quarts of vinegar to ten gallons of water. By immersing the clusters for a few moments in this diluted vinegar and rinsing twice in clear water, we are told on the authority of Dr. Neale, of Delaware, that the stains are effectually removed without appreciable injury to the bloom of the clusters, at a total expense of fifty cents to a thousand pounds. Professor T. advises orchardists not to undertake a large task at spraying until on a moderate scale they have become familiar with the details of the operation, or, in other words, until they have learned their trade.—*Country Gentleman.*

VIBRATING STRINGS.

THE effect of Mr. Melde's pretty experiments with the vibrating stretched thread attached to one of the prongs of a tuning-fork is often spoiled to the spectators by the unfavorable plane of vibration assumed by the thread. A very simple device removes this inconvenience, and enables the operator to suit his own choice for the plane of vibration. The accompanying sketch sufficiently explains itself, and shows the arrangement for restricting the vibrations to the vertical plane.

Instead of attaching the end of the thread to the prong of the tuning fork, it is tied to the middle of a short thread, dAe, and the ends, d and e, of this are attached to the prong in a vertical line. It is clear that if the distance of A from the line, de, is an appreciable

part of the quarter wave length of the vibration, and A B is an integral multiple of the half wave length, vibration is possible only in the vertical plane. For in the horizontal plane this rate of vibration is impossible, A being not a fixed point of the thread for vibration in this plane, and the length from the prong to the pulley being not an integral multiple of the half wave length of vibration. And in any other plane, the vibration, if possible, would be compounded of two, viz., of the vertical, which is possible, and of the horizontal, which is impossible.

The most convenient form of fixture for the short thread, dAe, is a light steel wire with an eye at each end, lashed to the prong with two turns of fine thread. The plane of vibration can then be easily adjusted to suit the spectators by slewing the wire in its lashing.

Note.—The triangular thread dAe should be of the same quality as the vibrating length. If it is much heavier, length for length, the arms of the triangle may become half wave lengths of the vibration for the tension employed, and then they lose their control over the plane of vibration.

The arrangement has its own worth, independently of the aid it lends to visible effect, as an illustration of the suppression of all half wave lengths which are not true sub-multiples of the vibrating length of the cord. When the fork is moved from its position in the figure to bring up the line, de, to the position of A, the vertical vibrations are suppressed, and only the horizontal vibrations are possible.—*W. Sidgreaves in Nature.*

THE MAGIC JAVELIN.

TAKE a sewing needle having a very sharp point, and of medium size. Stand about three paces from any sort of woodwork, and, holding the needle between the thumb and forefinger, try, by throwing it forcibly, to make it stick into the wood. Whatever be the dexterity and perseverance displayed, you will be unable to succeed.

Now pass a piece of thread through the eye of the needle, and you will succeed every time in sticking the

THE MAGIC JAVELIN.

latter into the woodwork that you have chosen as a target. The piece of thread that has been added will have converted the needle into a true arrow, and will cause the point, under the impulsion given, to strike the object at which it is aimed at right angles and permit it to affix itself thereto.

This result, which is quite surprising, will not fail to provoke the astonishment of the spectators and cause them to compliment you upon your wonderful skill.

The physicist Comus, the author of this experiment, concealed the means employed in an ingenious manner. From among several threads of different colors, he caused the one to be selected that it was desired that he should use, in order, said he, that it might be seen that it was indeed the same needle that was found affixed to the wood.

The thread, which in reality was the whole secret of the trick, appeared thus but a simple means of control to prevent any imposition. Allied to this experiment is the one with a pen provided with paper vanes (shown in the corner of the engraving), and which has caused many a task to be imposed upon school boys who preferred experiments in ballistics to the beauties of Homer and Virgil.—*La Science en Famille.*

FUNGI PARASITIC UPON INSECTS.

MR. ALFRED GIARD, the learned professor of the Normal School, has just published in the *Bulletin Scientifique de la France et de la Belgique* an interesting note upon some remarkable types of fungi parasitic upon insects. Without passing in review all the species studied, we shall merely cite two *Entomophthoræ* that present a peculiar interest. The two accompanying figures are taken from the colored plates that accompany the memoir.

The caterpillars of *Euchelia jacobeæ* are often attacked by the *Entomophthora saccharina.* In the summer of 1888, at Wimereux, says Mr. Giard, the *Euchelia jacobeæ* was particularly abundant. Almost every specimen of *Senecis Jacobæus*, var. *candicans*, was covered with caterpillars, and it was only within a space of about twenty square meters that the *Entomophthora saccharina* was met with.

Here all the plants were reduced to dry, defoliated stalks and branches. The dead caterpillars were fixed solely by their contracted legs. The spores that pro-

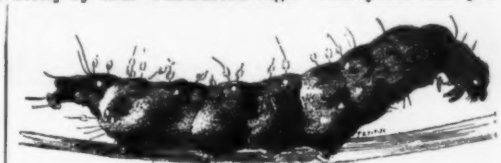


FIG. 1.—CATERPILLAR OF EUCHELIA JACOBEÆ INFECTED BY A PARASITIC FUNGUS.

duced this fearful epidemic adhered to the hairs of the dead caterpillars in the form of fusiform flocci. Fig. 2 represents a fly of the genus *Calliphora* killed in its habitual position, and the last rings of whose abdomen are partially covered with the spores of *Entomophthora Calliphoræ.* Prof. Giard explains the presence of this parasitic fungus upon Diptera as follows. The durable spores of *Entomophthora Calliphoræ* are swallowed along with the Diptera by batrachians, especially by the *Hyla arborea.*

The Diptera, weakened by the parasite, become a more easy prey to the batrachian. These spores germinate in the digestive tube, and take on their complete development on the excrement of the tree toad.

The *Calliphoræ* in turn become infested in searching for food in the excrement of the toad. Their presence alone and the motions of the tongue and feet suffice to favor the projection of the conidia. In the interior of

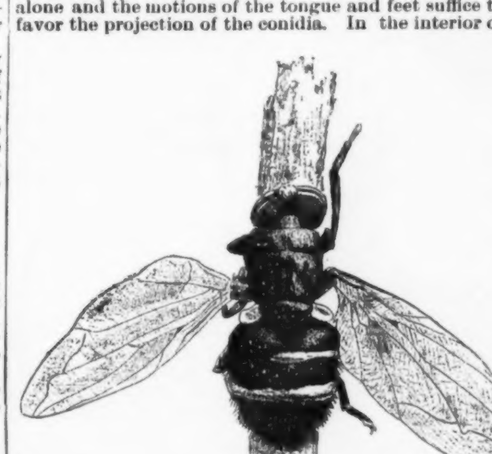


FIG. 2.—CALLIPHORA VOMITORIA INFECTED BY A PARASITIC FUNGUS.

the fly, the fungus produces durable spores only, that are incapable of directly reproducing the parasite in another fly without a new migration.—*La Naturaliste.*

PHOSPHORESCENT BACTERIA.

AT a recent meeting of the Royal Academy of Science, Amsterdam, Dr. Beyerinck treated of the luminous food and the plastic food of phosphorescent bacteria. Of the six species of phosphorescent bacteria hitherto known, four, viz., the alimental gelatine non-melting *Bacterium phosphorescens* and *B. Pflugeri* of luminous fish, and the Baltic phosphorescent bacteria, *B. Fischeri* and *B. balticum*, require, besides peptone, a second carbonic combination, as glycerine, glucose, or asparagine, for their complete nourishment, *i. e.*, to "phosphoresce" and grow. They may be called peptone-carbon-bacteria. The gelatine quick-melting phosphorescent bacteria from the West Indian Sea and the North Sea, *B. indicum* and *B. luminosum*, can phosphoresce and grow on peptone alone. They are, therefore, peptone-bacteria. Again, other bacteria can derive their nitrogen either from amids, the amid-bacteria, or from ammoniac, the ammoniac-bacteria. Also moulds, yeast, and some protozoa may be classed in this system. The *Bacterium Pflugeri* does emit light with peptone and glucose, but not with peptone and maltose, while the *Bacterium phosphorescens* emits light both with glucose and maltose. Now, if we mix

some starch in a phosphorescens-peptone-gelatine, obtained by mixing this gelatine with a very great number of *B. phosphorescens*, and place upon this some ptyaline, pancreas-diastase, or urin-diastase (nefrozymase), fields of light make their appearance; if, however, we placed these same sorts of diastase on a Pflugeri-peptone-starch-gelatine, then no fields of light would appear, which proves that in this instance no glucose whatever is formed, as was lately believed to be the case. The development of luminosity is constantly accompanied by the transition of peptones into organized, living matter, under the influence of free oxygen, with or without the concurrence of another carbon combination.

COIL FRICTION POWER TRANSMITTER.

THE power transmitter which we illustrate by the accompanying engravings is at the same time an ingenious novelty and a thoroughly practical appliance. To impart motion from a motor running at a given speed to machinery which is at rest, and to do this in such a manner that neither the moto[r] nor the recipient nor the intermediary, such as a belt, where one is used, is injuriously affected by the suddenness of the communication of the motion, has always been a difficult mechanical problem.

It is one which has constantly to be met, although often by admittedly unsatisfactory means, and the energetic and decided terms in which some engineers express themselves with regard to some forms of friction clutches afford explanation of the use of make-shifts and fast and loose pulleys. The necessity, however, for means of throwing machinery and shafting into or out of gear grows with the rapidly increasing extension of the use of machinery, and hence the employment of clutches made on various principles has grown rapidly in the last few years, especially in America.

In a large proportion of the cases of transmission of power to machinery it has always been desirable that the machinery should by some means be put gradually into motion, and in many cases where the rigidity of the means of communication or comparative rigidity has made this impossible, it has been necessary to start motor and machinery together. This is often difficult enough, even with steam engines, but it is much more so, and often impossible, with gas engines.

In all such cases a medium is required which will gradually increase the resistance it offers to the motion of the motor, and correspondingly gradually overcome the resistance of the machinery to be driven.

This can be done by the transmitter, and it owes its capability of doing this to the novel application of the friction of a coil. This coil is clearly seen in Figs. 1 and 8 of our engravings, which show it as closely coiled upon a cylinder, boss, or bush, as the inventor calls it.

The engravings show the invention applied as a clutch pulley. When used as a coupling, the shafts butt within the bush, one shaft being keyed to the bush, and the other to one external boss of the shell. The outside of the bush and the inside of the coil are carefully machined, and form a sliding fit. The bush is keyed to the shaft, and constitutes one part of the arrangement. The coil, with the controlling gear and case, form the other.

Both ends of the coil are attached directly or indirectly to the casing. The small or tail end is secured first to a ring, *f*, Fig. 1, which by means of a pin, *a*, and swiveling joint, *b*, gives a connection with a bell crank lever, *g*, working on a stud screwed in the case. The bell crank is controlled by the pressure of the spring, *d*, and the movement of the sliding bar, *c*—see Figs. 1, 2, 4, and 5.

The ring into which pin, *a*, is screwed contains several holes, and the adjustment for wear on the coil or bush is made by moving pin, *a*, into another hole. Any end movement given to *c* thus causes a tangential movement of *b*, and the ring and tail of the coil are forced round.

The large or head end of the coil is attached either direct or rigidly to the case, as in Figs. 1, 2, 3, or through buffer springs, as in Figs. 8, 9, 10. The former is done in Class B, and the latter in Class A, the head to which the coil is attached being differently shaped in each case.

Fig. 10 represents a development of the head in Class A, the buffer springs, *h*, lying between the projections on the head and lugs on the casing.

The case is made of two parts, jointed and secured with sunk bolts (see Fig. 6), each part fitting on the shaft by a bushed boss at each end.

In connection with the details of construction, it should be mentioned that the central chamber contains a quainty of semi-fluid lubricant, which lubricates every part, including the bearings. A taper plug, *e*, is fitted in the shell, and secured by small screws. At one end of the case a collar, *k*, holds in place a pair of starting rings, which, with the starting rod or handle, constitutes a self-contained starting gear, and dispenses with the necessity for any outside levers or fulcrums.

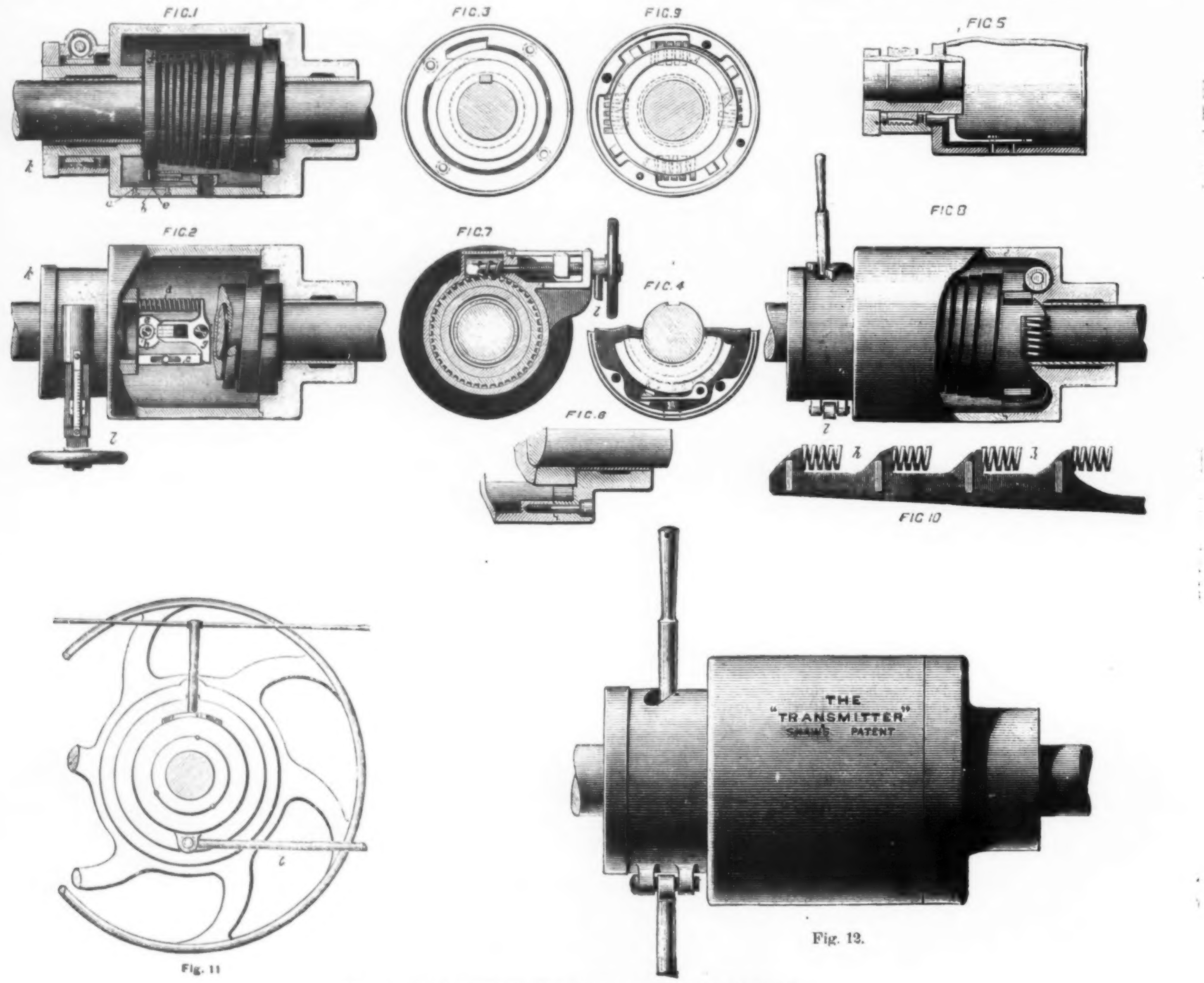
Several arrangements of starting rings are used, the object in all being to obtain an end movement of the inner ring along the shaft, so as to press an anti-friction slipper on the end of the bar, *c* (see Fig. 5), and give the tail of the coil a corresponding movement through the medium of the bell crank, *g*.

Figs. 2 and 7 show a slow starting movement in which the motion of the handle is communicated to a worm wheel, which, having a screw thread cut in the top of the worm teeth, gets simultaneously rotation and end movement. This arrangement is generally used with Class B.

Figs. 8 and 11 show a handle which gives this end motion almost instantaneously; the outer ring in this case is anchored by means of a pin and rod, *l*, and engages the inner rings on helical faces, so that circumferential movement of the handle gives end movement to the inner ring. The attempt to use coil friction is not new, but the difficulties which were met with caused its abandonment.

Mr. Edward Shaw, Canons Marsh, Bristol, has entirely overcome the difficulty by controlling the coil from the tail end instead of from the head. To illustrate the cause of this difficulty, we must point out the effect of change of the coefficient of friction. An alteration of the coefficient of, say, four times alters the effect in a very remarkable degree. Thus, assuming the coefficient = 0·025 and the conditions such that in the coil friction equation $R = e\mu\theta R = 100$ lb. Now, keeping everything else unaltered, yet supposing the surfaces run nearly dry, so that the coefficient becomes quadrupled, then the result will be $R_2 = (100)^4 =$ 100,000,000 lb., an alteration of result of no less than 1,000,000 times. Thus the transmitting power of the coil would in the first case be almost nothing, and in the second so great as to rupture a coil of more than 1500 square inches in cross section. Hence, an exceedingly small coiling up or uncoiling of the coil would make all the difference between looseness and rigid tightness.

Nothing but instantaneous gripping could be obtained, and hence the difficulty of the earlier inventors. The device was useless wherever the inertia of the machinery to be driven could have effect. The arrangement of the parts of the transmitter secures the full gripping power of a long metal coil under such conditions that a very slight force is sufficient to actuate it; and that, while it is able to overcome any resistance up to a certain limit, when that limit is exceeded the coil is caused to open and release its hold through the operation of a contrivance which virtually measures the power transmitted. Referring to the Figs. 8 and 9, it will be seen that, if the shaft and bush are revolving in such a direction as to drag the coil against the buffer springs, and the coil is made to grip at the tail end, the effect of this initial grip will be multiplied with each turn of the coil until the buffer springs, *h*, which are held back by the case, are compressed to an amount depending upon the resistance applied to the case either by a pulley or by any other means. Thus it is that a relative movement between the coil and the case takes place, accompanied by a resistance varying with the compression of the springs. The tail of the coil is actuated in the way shown in Figs. 1, 2, 4, and 5. The initial grip at the tail of the coil is due to the action of spring, *d*, and it will be seen that as the buffer springs are compressed, the tail of the coil moves under the pressure of *d*, the bell crank lever turning on its fulcrum and the sliding rod, *c*,



COIL FRICTION POWER TRANSMITTER.

moving so as to bring the slipper against the end face of the inner starting ring. Now, according to the position of this face, the movement of c will be more or less quickly stopped, and directly it is stopped the tail of the coil becomes fixed relatively to the case, and any further movement at the head of the coil due to the compression of the buffer springs will have the effect of relaxing the grip of the coil. To sum up the action of the whole arrangement, the position of the inner starting ring limits the travel of c, and thus the forward travel of the tail of the coil and the amount of compression of the buffer springs at the instant when the coil ceases to increase its grip on the bush. By means of the starting gear described the operator can alter the position of the inner ring, and thus exactly limit the gripping power of the coil. The addition of a very simple stop arrangement limits the travel of the rod, c, so that the operator can only control the amount of grip up to the limit fixed by the stop. With class A the transmitter can be put suddenly into gear, the maximum gripping power being instantly attained, and, however great the resistence of inertia, the machinery is quickly started without shocks or overstraining of parts. In addition to this is the advantage that, should the resistance due to choking of machinery or any other cause suddenly become dangerous, the automatic release will take place, and sliding occur until such resistance is removed. Class B is identical in its action except that the elastic elongation of the coil is the only substitute for the buffer springs; it possesses the advantage of class A, except the automatic release. The elastic elongation of the coil, however, is quite sufficient to insure thorough ease and safety in starting. Among the advantages claimed are those depending upon the principle of action of the transmitter, as well as upon the many good features in its construction. It differs from all friction clutches in this essential feature—instead of the gripping power depending upon two uncertain factors, namely, pressure brought to bear between surfaces and the coefficient of friction between those surfaces, it is independent of both, and entirely regulated by the amount of movement of a handle or wheel. One great advantage of this is that there is never any danger when once in gear of slipping taking place, except under the automatic release. Another feature is that the effort necessary to control the transmitter is so small that it is easily actuated from a distance by means of tight rods or cords (see Fig 11). Other features are the bearings at the end of the transmitter, providing, when pulleys are keyed as recommended on the large part of the transmitter, a central pull for the belt, the absence of any projections on revolving parts and of end thrust on the shaft. The construction is very simple and the working parts are not liable to get out of order. Transmitters have been tested in actual use for nearly two years, and, owing to the nature of materials employed both for the coil or bush, coupled with the fact that they work in a bath of oil, the amount of wear which takes place is practically negligible even under severe conditions. They are in use on gas engines up to 50 indicated horse power, and in their application to shafting and various kinds of machines have greatly increased the life of the belting by which they are driven, and afford ease and safety in the intermittent use of gearing. Fig. 12 is an exterior view of the coupling.—*The Engineer.*

THE RAILROADS OF MEXICO.

FOR a few years past, the railway systems of Mexico have been increasing in notable proportions. It was especially between 1880 and 1884, that is to say, under the administration of General Gomez, that the infatuation for railway enterprises reached its climax. This fact is explained by the facility with which the government made its concessions, almost all of which were so liberally subsidized that, in 1885, there resulted a financial crisis that necessitated a suspension of payment of the subsidies, and work on most of the lines in course of construction was stopped until the end of the year 1886, when the contracts made with the grantees were revised upon bases better in accordance with the state of the treasury.

The government of General Gonzalez certainly gave proof, as regards railway constructing companies, of a prodigality the financial condition of Mexico did not seem to authorize, but it is just to recognize the fact that he acted with a patriotic object in view, realizing that the development of railways must be the axis of the material progress of a country the exploitation of whose natural wealth is rendered impossible by the absence of railways and navigable waters. Large subsidies were therefore indispensable, for the capital engaged in construction ran the risk of remaining unproductive for a long time in a country where the industries are yet in their infancy and where fuel is very scarce.

The energy of General Diaz put an end to the financial embarrassment which had temporarily stopped the progress of affairs, and work on the railways was resumed with astonishing activity, and the systems ought this year to reach a development of 6,000 miles.

We propose to give a few data concerning the principal lines in operation or in course of construction, and more particularly concerning the one running from Mexico to Vera Cruz, the first one established in Mexico, and which, by the boldness of its direction line and the extent of its traffic, merits special mention. According to the annals of the minister of public works, there were, at the end of 1888, 47 lines in operation (urban railways and tramways not included) representing a length of 4,293 miles.

The Central Railway.—The first design for a railway starting from Mexico and running north was rendered in 1857 by President Ignacio Comonfort, who authorized the formation of a company with $3,000,000 capital, divided into 300,000 shares of $10 each. As the formation of the company was unsuccessful, things remained in *statu quo* until the year 1874, when a contract made between the executive power and Messrs. Camacho, Mendizabal & Co. for the construction of a railway between Mexico and the city of Leon was approved by congress. In 1876, this company was deprived of its rights for not having conformed to the conditions stipulated in the act of concession, which, in 1880, was transferred with some modifications to Messrs. Robert Symon & Co., of Boston. As this company possessed all the means of execution necessary, it obtained authority from the government to establish a broad gauge road to connect the capital with the frontier of the United States, and another one to unite San Luis de Potosi on the one hand with Tampico, and on the other with San Blas on the Pacific Ocean.

The line from Mexico to the United States, called the Central Railway, is 1,188 miles in length. It connects the cities of Queretaro (30,000 inhabitants), Leon (50,000 inhabitants), Aguas Calientes (32,000 inhabitants), Zacatecas (45,000), Chihuahua (25,000), and reaches the frontier at Paso del Norte, where it connects with the

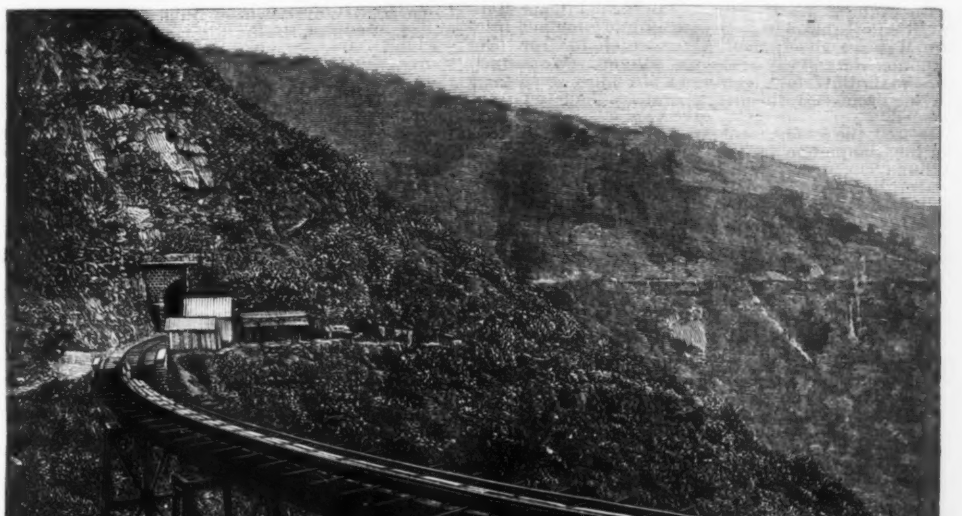


FIG. 1.—THE WIMMER VIADUCT ON THE LINE FROM MEXICO TO VERA CRUZ.

Santa Fe, Atchison and Topeka Railroad, the Texas and Pacific Railroad, and the Southern Pacific.

The work on this line was finished in 1884. According to the terms of the concession, the line will make a return to the state at the end of ninety-nine years.

First class passengers alone have the right to occupy the Pullman cars day and night, for the additional fare of $9 per bed or $34 per private saloon from Mexico to Paso del Norte. The company carries 33 lb. of baggage free, if the ticket has been purchased from one point of the Mexican line to another point of the same line. If the ticket has been purchased in the United States, or for the United States, 155 lb. of baggage are carried free.

Up to the present, the exploitation of this line has not justified the expectations of those who constructed it. The trouble is due to the inability of the government to meet its liabilities as regards the payment of the subsidy, and to the insufficiency of the traffic. The road, in its southern part, passes through a region rich in mines and highly agricultural, and connects several

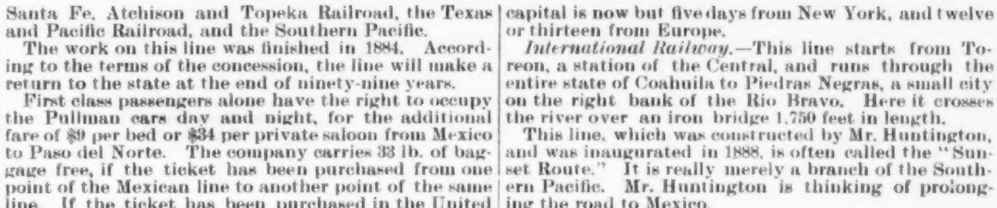


FIG. 2.—MAP OF MEXICAN RAILWAYS.

large centers of population, but, in the northern part of the country, it runs through desert and sterile regions. The grantees certainly gave proof of want of foresight in supposing that a railway established in a Hispano-American country could, as has been done in the United States, give rise of itself to a traffic sufficiently remunerative for so important an enterprise.

The National Railway.—This railway consists of two sections. The first starts from Mexico, and, running toward the west, is to reach Manzanillo, on the Pacific, passing through Toluca and Mozelia. The work is now finished up to Patzcuazo, a small city 264 miles distant from Mexico. The other section branches from the preceding at Acambaro, and, following a northerly direction, intersects the Central Railway to the west of Queretaro, runs to San Luis, Salado, Satillo, and Monterey to enter the United States at Nuevo Laredo, where it connects with the Texas lines. This section was completed in 1888. This railway is a narrow gauge one. The company is also lessee of the line that connects Matamoros, on the Gulf, with Nuevo Laredo, and the work on which is finished for a distance of 72 miles. Since February 27 of this year, there has been a service, three times a month, of fast trains between Mexico and New York, and *vice versa.* The Mexican capital is now but five days from New York, and twelve or thirteen from Europe.

International Railway.—This line starts from Toreon, a station of the Central, and runs through the entire state of Coahuila to Piedras Negras, a small city on the right bank of the Rio Bravo. Here it crosses the river over an iron bridge 1,750 feet in length.

This line, which was constructed by Mr. Huntington, and was inaugurated in 1888, is often called the "Sunset Route." It is really merely a branch of the Southern Pacific. Mr. Huntington is thinking of prolonging the road to Mexico.

The Interoceanic Railway.—This line consists of a broad gauge section that starts from Mexico, runs toward the east, enters the districts that produce pulque (the national beverage) and, following a route a little more to the south, passes to Irolo and reaches Calpulalpan at 72 miles from the capital.

The success of this section encouraged the promoters to prolong the line from Irolo to Perote, *via* Puebla. Work on this was finished last July. There remains only 118 miles to construct between Perote and Vera Cruz. The Interoceanic after the completion of its southern section (from Mexico to Acapulco) will be able to compete advantageously for through traffic, as it is doing already for local traffic.

The eastern branch will begin then at Vera Cruz, where a mole and wharf will be constructed, and will traverse the cities of Jalapa, Perote, Puebla, San Martin, and Mexico. The Pacific branch will start from Mexico and reach Amacusac after passing through the cities of Ameca, Ozumba, Cuantla, Morelos and Yautepec. The section from Yautepec to Amacusac will do service for the rich valley of Cuernavaca, where are located large sugar works and distilleries,

agricultural exploitations of the first rank, and gold, silver and cinnabar mines that are reputed to be very rich.

Mexican Southern Railway.—A company with a capital of £1,000,000 has just been organized at London for the purpose of constructing a narrow gauge railway from Peubla to Oaxaca (but which will probably be pushed further), and which is to establish a direct connection between the southern states of Mexico and the port of Vera Cruz. This line will have a total length of 249 miles, and will be divided into three sections. The government has granted the company an annual subsidy of £80,640 for a period of fifteen years.

The Tehuantepec Railway.—The Tehuantepec Railway Co., organized in New York in 1870, obtained from the Mexican government a concession for the construction of a railway across the isthmus. Work upon this was finished for a length of a few miles, when fever having decimated the men, operations had to be suspended.

In 1882, the government treated with the Mexicans for the completion of the line, which was to be 184 miles in length, and to start from the mouth of Coatzacoalcos River on the Atlantic and end at the port of Salina Cruz on the Pacific. These new grantees have constructed a few miles of track (26 miles) at the north, and a few (36) at the south of the isthmus, but for want of funds, suspended work a long time ago.—*Abstract from Le Genie Civil.*

OMNIBUS WITH ROOFED IMPERIAL.

MR. AUDIGER has recently patented an omnibus designed to shelter the passengers in the imperial as well as those inside. To this effect, it was necessary

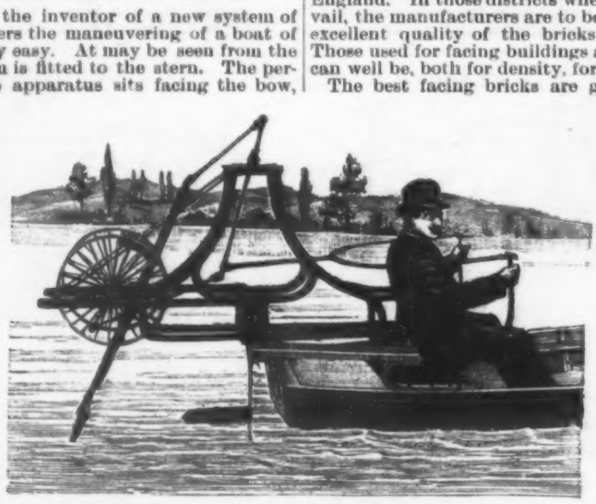
OMNIBUS WITH COVERED IMPERIAL.

to construct a vehicle light and strong enough to present guarantees of sufficient security. One of the principal conditions was to construct the imperial light enough to keep the center of gravity low.

The "Indispensable," as the vehicle is called, appears to us to realize this desideratum. We shall not enter into the details of construction, which Mr. Audiger has reserved for his manufactory, but shall be content to make this improvement known to the proprietors of public carriages, who may increase their profits by carrying passengers in the imperial in all sorts of weather.—*Les Inventions Nouvelles.*

PROPELLER FOR PLEASURE BOATS.

MR. E. POMBAS is the inventor of a new system of propeller which renders the maneuvering of a boat of small dimensions very easy. At may be seen from the figure, the mechanism is fitted to the stern. The person who actuates the apparatus sits facing the bow,



PROPELLER ADAPTED TO A ROW BOAT.

and grasping the two handles, gives them a backward and forward motion, which, through the intermedium of levers and cranks, transmits an impulsion to the paddle. The frame that supports the latter, and the lever and the operator's seat, are all keyed upon the vertical rod serving as a rotary axis for the rudder. Through a very slight stress of the loins upon one leg or the other, the whole frame is made to turn in one direction or the other, along with the rudder that serves to steer the boat. A woman and a child can easily, and without fatigue, perform the simultaneous functions of rower and helmsman. By practice, a man can make three and one-half miles per hour.

This system presents numerous advantages over oars. It permits one to operate both the propelling apparatus and the rudder. The operator faces the bow instead of the stern, as in all other systems. The maneuvering is simple and hygienic, for there is scarcely any fatigue, since the stress to be made is a simple traction toward one's self, and the motion is so balanced that the return takes place of itself. As the apparatus is placed at the rear of the boat, it permits the latter to enter narrow passages. As the paddle enters the water to a depth of but ten inches, the boat can be navigated in water whose depth does not exceed twelve inches, and can be passed over rapids with relative ease.—*Les Inventions Nouvelles.*

BRICKMAKING IN AMERICA.

By W. JOHNSON, M.I.M.E.

ANY one paying his first visit to America cannot fail to be impressed with the business energy and enterprise of its people; and looking abroad, and considering what it is that inspires this, the cause is very apparent. In America it seemed to me to be the ever opening up of new resources which excites the energies of the people, and spurs them on in untiring industry. These resources are also as varied in their character as in their richness, so that, whatever branch of industry is considered, the same tempting bait is offered. The branch of industry in which I was more especially interested was that of bricks and kindred manufactures. The leading building material almost everywhere in that country is brick. Granite, marble, and building stone of good quality are abundant, but they lie remote from the cities generally, while excellent brickmaking material is almost everywhere abundant.

One peculiarity of this material as compared with that in our country is that it is almost everywhere of the same character, viz., a loamy material; but it contains sufficient alumina to make a sound and strong brick. It will admit of a thorough firing, and comes out a bright red color. Around Philadelphia and all the way to Washington, and around St. Louis, are found, perhaps, the richest clays; but the districts where brickmaking material is not found are very rare indeed. In the neighborhood of Chicago the clay is weaker and stony, and produces an indifferent brick; but in the State of Indiana, and not far away, is again found clay of good quality, and, notwithstanding the rapid expansion and growth of that city, I found that bricks were sold there at much less price than in any other part.

Again, in Canada the same characteristic of the clays prevails; and coming round again across the St. Lawrence, and all through Maine, Massachusetts, to New York, New Jersey, etc., and also in those States lying between, is found the same. The peculiarity of prevailing sameness to me was most remarkable, accustomed as I am to such variation as is everywhere found in England. In those districts where the best clays prevail, the manufacturers are to be recommended for the excellent quality of the bricks which they produce. Those used for facing buildings are as perfect as they can well be, both for density, form, and color.

The best facing bricks are generally produced by handwork. The Americans in their brickmaking are ahead of us in some respects, and in none are they more so than in their careful preparation of the clay before it is made up into bricks. It is usual with them to dig and heap it up for a thorough weathering; then in using it is tipped into what they call a tempering wheel pit. This is about 3 feet deep by 24 feet in diameter, and is filled level with the surface with the clay, water is sprinkled over it as required, then the tempering wheel is set going. The wheel is about 5 feet in diameter, and consists of two or three rims of iron, of about 1 inch section, which are tied together 1 inch apart, and form one wheel. The cavities between the rims give them an increased kneading effect. The wheel is supported in the boss by an iron arm, which extends to the outer rim of the pit, and is drawn either by a horse or by power.

The wheel works loose on the arm, and as that is drawn along the wheel revolves in the clay, cutting and kneading it as it travels through it round the pit, and by an ingenious arrangement is made to cover every part of it, and change its course at every circuit from the inside of the circle to the outer, then back again to the inside, and so continue without any attention, never going more than one round in the same groove. It is allowed to run thus for twelve hours, when the clay, after having been patted and smoothed over the surface, is allowed to remain over night, and the next day it is mellow and in good condition for being moulded into bricks either by machine or by hand. The pit holds sufficient clay for 20,000 bricks, and two or more pits with their wheels are required to keep a yard going, according to its size. The plan is purely American, and it would be rather interesting to know the origin of it. The tempering is certainly done very thoroughly by it, but it might be done equally well with greater economy.

The superior character of the clay which prevails generally gives one very little difficulty in dealing with it in any of these processes. There is very little hand moulding, and machinery is almost everywhere in use. The Americans have what they call three classes of brickmaking machinery, viz., the mud, the stiff clay, and the dry. The mud or soft clay process is most generally in use. In this process the clay is usually prepared by the tempering wheel, and in some cases by shovel and hand tempering. It is then supplied to a vertical square pug mill. At the bottom of this is an arm or wiper, which forces the clay into a chamber situated on the outside of the pug mill, but attached to it. In this a plunger works vertically. Six bricks are made at once, and the moulds are formed in one frame, which is placed in position by hand, so that an arm in the machine can push it under the plunger to be filled. This forces the clay into the moulds; the empty mould in being pushed into position for filling pushes forward the one previously charged ready for being taken away, and is emptied on to a pallet which is placed on an incline on a circulating disk holding several pallets. These are then lifted on to a wagon, the pallets containing the bricks being placed one upon another on a wagon holding 500 bricks.

This is then run into a drying chamber, and, after remaining there for twenty-four hours, is ready for being set in the kilns. The moulds have bottoms in them, and are sanded for the double object of enabling the bricks to leave them freely and to leave them sanded over the surfaces. An ingenious method is adopted for sanding the moulds mechanically. This machine is capable of turning out 40,000 bricks per day, but 25,000 is the usual day's work, and in Canada 12,000. The slower the machine is worked, the better is the quality of the brick produced. In Canada a very good brick is made which is used for facing work without repressing, as well as for ordinary purposes. This process is the nearest imitation of handwork, and is almost everywhere in use.

This method has undoubtedly advantages. There is a saving over hand moulding, and the bricks so made are quite as good; and in stony clays, where for making ordinary bricks it is not necessary that they should be either crushed or cleared out, it is a useful process, and the machine takes little power and gives little trouble, and it seemed to me that it might be adopted in the London stock brickyards with considerable advantage. But as it is employed in America most generally it would, no doubt, be greatly improved upon in respect of economy in brickmaking, and without any deterioration in quality.

The stiff clay process is by the pug mill and wire cutting method. There is in the country a very great variety in the machinery of this type, and each with varying merits. Both vertical and horizontal machines are employed. Some of these are small, and others excessively large; but it seemed to me that the designers of the whole of them had failed to comprehend the actual requirements for brickmaking. There are several machines which combine the vertical with the horizontal type, but for what good purpose it is difficult to understand. Good work is done by perhaps all the machines; but it is done with much waste, both in wear of machines and power taken up in driving. There is one machine, of which I saw several in use, which I thought to be the best. It turns out a large quantity of bricks, but they are of the roughest quality, and are only used for inside work.

Considerable advantages are claimed for this machine, the specially valuable feature which is claimed for it being its automatic cutting off, but the quality of bricks made by it would not be used for any purpose in this country, and we greatly excel it in many respects, the foremost being in quality, in amount of power it takes, and in wear, and the advantage in the automatic cutting off is also more apparent than real. America, with all its genius for invention, and its variety of brickmaking machinery, has yet something to learn from the old country.

There is perhaps quite as much variety in machinery for the dry brickmaking process as for the stiff clay, and I cannot speak too highly of much that I saw of this class. There are several notable failures which were accountable for a vast waste of capital, of which I saw several instances that confirmed my unfavorable view of them. One serious defect, which I noticed in all alike, was the extreme porousness of the brick made by this process.

The method adopted for charging the moulds in all the machinery of this type alike is responsible for this. The clay in many parts is specially favorable for making bricks by the dry process; and if the Americans would adopt the plan of repressing the bricks as they come from the machine, they would be very much improved in this respect. There is an entire absence of our semi-plastic process being employed in those materials which are being worked on the dry plan; very superior results as to quality might be produced by this. In the methods adopted for brick drying, American brick manufacturers are much in advance of us. Artificial drying chambers are almost everywhere adopted. The plant for this, in the first instance, is expensive, but the cost is recouped many times over in the great saving in labor in permanent working. Various methods of heating the chambers are adopted—some with fireplaces, others with pipes heated with steam, others hot air, and again with fire fumes passing through the body of bricks. All these methods are more or less successfully employed. Ordinary drying floors, which involve labor in the bricks being put down and taken up again, are not in favor. The excellent character of their brickmaking material favors them here again in allowing the bricks to be rapidly dried, which is generally performed in twenty-four hours.

In their methods of burning their bricks I consider

the Americans much behind us here. The Hoffmann kiln, I believe, has no existence there as yet, or even any of the greatly improved methods of burning; the old-fashioned open case is everywhere in use. There are a great many so-called patent kilns, but the alterations from the most ancient type are almost without a difference, and in some cases are a decided deterioration from the original. Very great improvement might be made in their method of burning, and I was much surprised to find that they had been so slow to realize this.

In sanitary pipe manufacture the Americans are fairly well abreast of ourselves, and in some respects I must allow them to be in some measure ahead. They prepare the clay well, and are alive to the saving of labor in the detail of the manufacture. Too much cannot be said of their firebrick making. This is universally carried on by handwork. In preparing the clay the tempering wheel before referred to is employed, and in some instances the solid bottom edge-runner mill. In Pennsylvania they are somewhat ahead of other parts, both in their mode of manufacture and in burning. They are slow to realize the advantage of employing machinery in this manufacture; but in this there is little to boast about even with us.

In Scotland they are just beginning to realize that equal results with hand labor are to be obtained from machinery, and with a great reduction in cost of manufacture, and machinery is now becoming adopted, and is increasingly inquired about. The Americans are also beginning to awake to the advantages which are to be gained by the use of machinery. One firm in Massachusetts has put down a model firebrick-making plant in which machinery is fully employed, and also a greatly improved method of burning, and their example will no doubt be largely followed by others by and by, for the Americans are quick to adopt improvements and economical methods as soon as they become convinced of their genuineness.

I specially noticed the poor quality of the white and buff building bricks, and the almost entire absence of the manufacture of white and colored enameled bricks. There is an abundance of material that is suitable for all these; but as yet the manufacture in them is very limited, and the few that are produced are of very inferior quality. I found that this class of bricks is largely imported from England, and the trade in them might be largely increased if English manufacturers were more alive to the openings there are for trade in this direction.

The difficulty which the Americans have to obtain them makes the use of this class of brick very limited, and I noted a very earnest inquiry among the brick manufacturers in the country to be enabled to produce them. If English manufacturers would cultivate this trade, I saw sufficient to convince me that they would find a demand equal, perhaps, to the whole production of this country. The Americans say that they do not use them for the simple reason that they cannot be got, not because they are costly, although the tariff added to the original cost here makes this considerable, but the complaint is that they are unable to obtain them. Silica or ganister bricks seem to be entirely unknown in the country so far as their manufacture is concerned. The Americans have the natural material, but as yet the manufacture has no place in the country; but there is an inquiry for this class of brick which should enable the Americans to produce them.

I noticed the pottery branches were fairly well developed. An excellent quality of terra cotta goods is manufactured in the neighborhood of Boston, but this is not nearly so largely developed as there is clearly a scope for in this class of goods. Pottery ware is produced, but the country is still largely dependent upon importation for the best ware.

I had noticed previous to my visit a boasting that in this branch the Americans were leaving Staffordshire in the rear, but in my observations I failed to find evidence that they were at all near in the race. I noticed much pottery ware that was very fine, for the Americans possess considerable artistic taste, and an eye for the beautiful, of which I saw abundant evidences, but for the gratification of much of this they are dependent upon England, and perhaps in nothing more than in pottery ware.

My observations extended to many other branches of industry, but as I was more especially interested in those referred to in these notes, and therefore gave particular attention to them, I found the opportunity most valuable in obtaining information and also many useful hints, which will no doubt be taken advantage of at the proper time.—*The Architect.*

THE MANUFACTURE OF VINEGAR.

VINEGAR, as well known, is obtained through the conversion of alcohol into acetic acid, in contact with the air, as a consequence of the absorption of a certain quantity of oxygen.

Every liquid containing alcohol, or capable of becoming alcoholic through fermentation, may therefore be used in the manufacture of vinegar.

Various processes have been devised for effecting the conversion. The old Orleans one, especially applicable to wine, would be the best of all, if the work could be carried on more rapidly.

The German process considerably hastens the acetification through a peculiar arrangement of the apparatus, and one that multiplies the points of contact with the air. To this effect, a tun 6 feet in height and 3 feet in diameter is used. This is placed in a vertical position and is divided into three compartments by two horizontal perforated partitions. The middle compartment is filled with loose beech shavings; the upper one receives the liquid, which falls upon the shavings by following strings passing through the apertures of the upper compartment; and the lower one receives the vinegar, which is drawn off from time to time. The air enters the tun through apertures in the lower part of the central compartment, traverses the shavings from bottom to top, and escapes, deoxygenated, at the top of the tun, through a tube. This very expeditious process has one drawback. In consequence of the activity of the acetification, there is an elevation of temperature, whence results a loss of a certain quantity of alcohol and acetic acid, and especially of the greater part of the volatile aromatic principles, since the circulation of the air upward favors the carrying along of the vapors.

The German process with stationary tuns, of which we wish to recall the essential arrangements, has been converted into a process with revolving tuns by different inventors. We shall mention especially the Michaelis system, of which Messrs. Agobet & Co. are the grantees, and which they have improved in such a way as to obtain apparatus that realize an important progress upon all that has been done in this line up to the present.

As it was first constructed, the Michaelis apparatus comprised a series of tuns placed horizontally upon blocks. Each of these was divided by an open-work partition into two unequal compartments, the smaller of which (the upper one) was filled with beech wood shavings. The air entered through an orifice in one of the heads a little beneath the partition, and made its exit through the other orifice formed in the upper part of the opposite head, after traversing the shavings diagonally.

The liquid to be acetified was poured into the lower compartment. The tuns were made to turn a half revolution at regulated intervals, so as to immerse the shavings in the liquid and to afterward bring them back to the upper part, in order to make them undergo the action of the air. Later on the Messrs. Michaelis suppressed the partition and filled the tun full of shavings, as shown to the left of Fig. 5, which represents the Michaelis tun, while the part to the right shows the improvements devised by Messrs. Agobet & Co.

It will be understood that the loss is much less than in the old system with stationary tun. Despite that, the diagonal current of air still carried along a part of the volatile matters.

In order to remedy this inconvenience, Messrs. Agobet & Co. have patented a siphon tube, which they have applied to their improved apparatus, but which can be applied also to the old Michaelis apparatus. Under these conditions the latter leave nothing to be desired.

The improvements introduced by Messrs. Agobet & Co. into the Michaelis system of revolving tuns consist principally in new means for facilitating the entrance and exit of the air without the creation of a pernicious current and in a new mechanism that permits of revolving together, and at the same angle, all the tuns of a row.

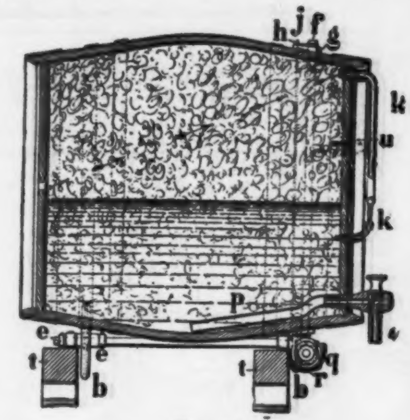


Figure 1

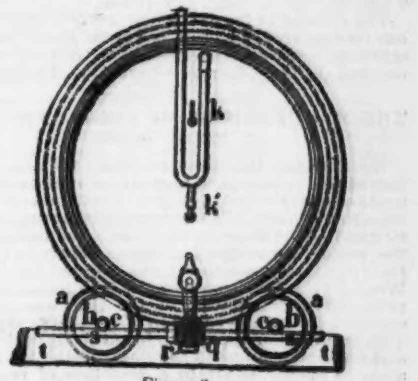


Figure 2

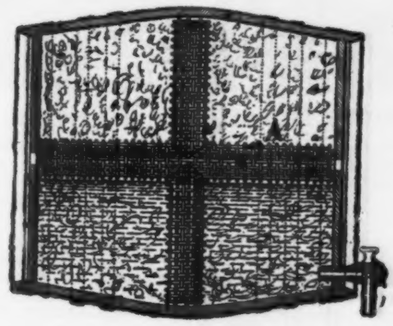


Figure 3.

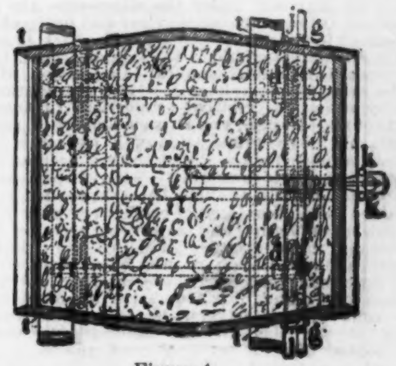


Figure 4.

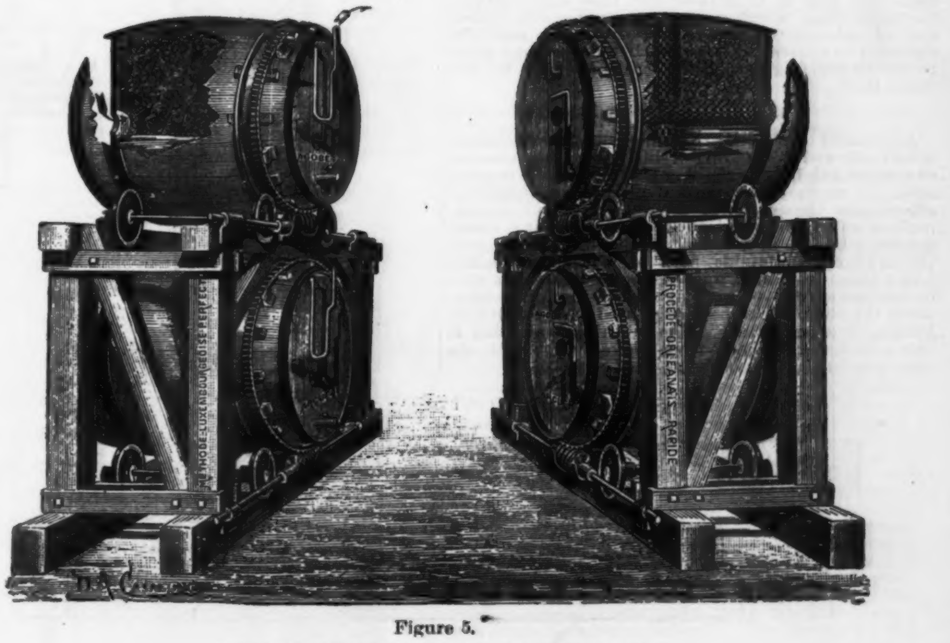


Figure 5.

MANUFACTURE OF VINEGAR.

The new acetifying tun is represented in vertical section in Figs. 1 and 3. Fig. 2 is a front view showing the maneuvering mechanism, and Fig. 4 is a horizontal section. Finally, Fig. 5 gives a general view of the Agobet apparatus. The tun is of oak. It is filled with beech shavings, and has, in the center of each head, an aperture two inches in diameter, which communicates with air chambers. These latter consist of the two branches of a tubular cross of osier, A, one arranged according to the axis of the tun and the other according to a long diameter.

The osier tubes are 4 inches in diameter. This wide section permits of the easy entrance and escape of the air. The tun rests upon two rows of wheels. Those figured *a* are placed behind and are loose upon their axes and bear upon a rolling circle or simply upon wood. The others, *b*, which are smaller, revolve in a channel, *j*, formed upon a rack, *f*, fixed upon the tun by wedges, *g*.

The supports of the wheels are fixed upon a frame, *t*. An endless screw, *q*, engaging with the rack, serves to make the tun revolve. One and the same shaft, *s*, carries the screws, *q*, of an entire row of tuns. The tube, *p*, forms a siphon and serves to draw off the liquid when the acetification is complete.

A thermometer, seen in Fig. 2, between the two branches of the siphon, K, indicates the internal heat of the apparatus. The glass siphon tube, *h*, communicating with the liquid through the small tube, *h'*, serves as a level, and, at the same time, as a vent for the passage of the deoxygenated air, with return of the condensed vapors. This siphon tube, adapted to the old Michaelis apparatus, suppresses the inconveniences thereof, as we have above stated.

The vinegar is manufactured as follows:

The shavings having been previously acetified with vinegar of alcohol, which is afterward drawn off, the liquid is introduced up to the level of the central aperture, and the room is raised to a temperature of 26 or

28 degrees, or even to 30 degrees. A high temperature hastens the transformation, but it increases the loss through the evaporation of the alcohol, acetic acid, and aromatic ethers. Here, however, the inconvenience is less, because there is no upward current of air, and the horizontal tube is constantly pressed by the external air, which tends to enter the apparatus by reason of the vacuum created therein in consequence of the absorption of a portion of the oxygen of the internal air.

The level of the liquid to be acetified rises to 1⅛ inch beneath the air holes. This liquid should have a temperature of 25 or 30 degrees before its introduction.

After the vessels are charged they are at first revolved but three times a day, the first revolution at 6 o'clock in the morning, the second at noon, and the third at 6 o'clock in the evening. On the third and following days they are revolved six times; the first revolution at 6 o'clock in the morning, the second at 9 o'clock, the third at 12 o'clock, the fourth at 3 o'clock, the fifth at 6 o'clock, and the sixth at 9 o'clock.

The vinegar is finished when every trace of alcohol has disappeared, and this is known when the vinegar marks as many acetic degrees as the mixture employed marked alcoholic degrees.—*Chronique Industrielle.*

THE MANUFACTURE OF PORTLAND CEMENT FROM SLAG.

WE illustrate the plant necessary for the manufacture of this cement, and now give a brief outline of the mode of manufacture. A good Portland cement made from slag consists of an intimate mixture of granulated slag and about 25 per cent. of lime, reduced to a very fine powder by mechanical means. Early in the manufacture of this cement it was pointed out by Mr. C. Wood, of the Tees Ironworks at Middlesbrough, that a preliminary granulation of the slag was absolutely essential for the preparation of a satisfactory cement. This granulation appears to bring about both chemical and physical changes in the slag, causing the silica and alumina present to attain a condition of readiness to combine with the lime which is subsequently added, and when examined under the microscope the granulated slag is found to contain clear and brilliant grains embedded in the matrix instead of the dark aggregates which are characteristic of the original slag. In fact, it is possible by a microscopical examination to judge of the value and completeness of the granulation process by noting the relative proportions of these two kinds of appearances, and it is customary to reject as unsuitable for the preparation of a hydraulic mortar those granulated slags which show a preponderating number of black granules. Early experience also established the fact that the basic slags, such as those obtained in the basic steel process, were only suitable for this manufacture, and at present, even by largely increasing the percentage of added lime, the almost neutral and acid slags have not been rendered available for cement making. In calculating the amount of lime to be added, it is found that when the ratio of the sum of the oxygen in the silica and alumina of the slag to the amount of oxygen in the added lime is as 2:1, then the best quality cement is obtained. According to Tetmajer, when the ratio of lime to silica in the slag is less than one, than the slag is unsuitable for this manufacture. In those slags which contain an appreciable quantity of calcium sulphide this substance must be regarded as equivalent to so much lime present, since in the process of granulation it is decomposed by the water thus:

$$CaS + H_2O = CaO + H_2S.$$

As pointed out by Mr. Redgrave in the discussion which followed the reading of his paper, the presence of calcium sulphide in the slag is of very small importance, as up to 3 per cent. it produces no injurious effects upon the quality of the cement, except rendering it slightly slower in setting. Sometimes it is found necessary to add, in addition to the lime, some gelatinous silica and alumina, both of which can readily be obtained from some unused slag by treating it with hydrochloric acid and filtering off the insoluble silica, when the alumina can be precipitated from the filtrate by the addition of lime. The additional alumina is also sometimes obtained from sodium aluminate, obtained by fusing bauxite with soda.

In Figs. 1 and 2 are shown one of the forms of plant employed in Germany for converting the quicklime into dry slaked lime. It possesses the advantages of being very convenient for regulating the quantity of water to be added, of lessening the amount of hand labor, and preventing the formation of dust, which is so injurious to the workmen. The lime in coarse lumps is placed in the receiver Q, which rests on rollers and is inclosed in the larger cylindrical vessel P. This vessel P can be closed at S after the lime is introduced, L being a safety valve and pressure gauge to record the pressure, which may rise to 80 lb. or 90 lb. per square inch. The water is introduced by opening a cock which allows the water from a reservoir to flow down O into the pipe K J, which distributes the water uniformly over the lime. After remaining in the apparatus for some little time, the heat generated by the slaking causes the excess of water to pass away from the lime and condense on the walls of the containing vessel, so that on removal the lime is found to

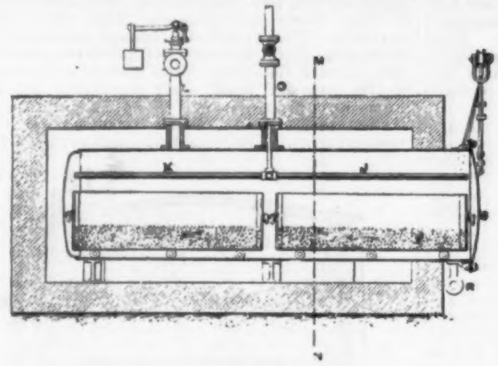


FIG. 1.

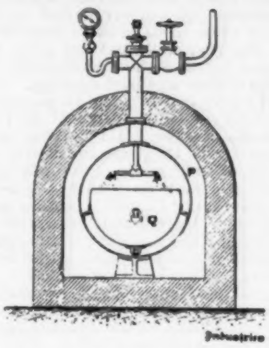


FIG. 2.

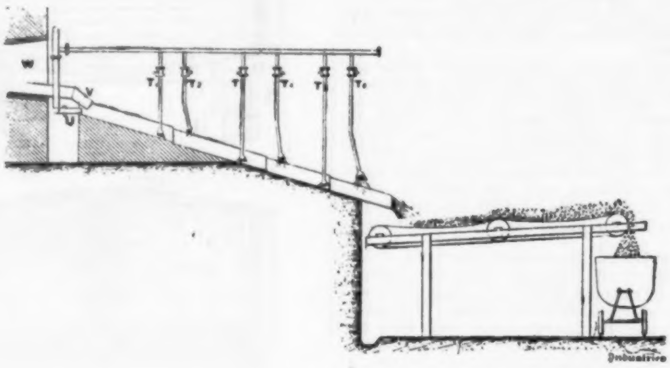


FIG. 3.

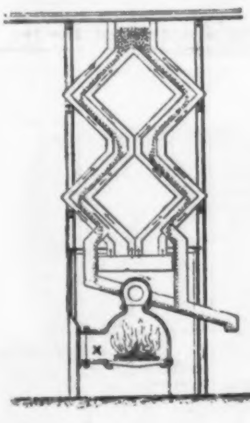


FIG. 4.

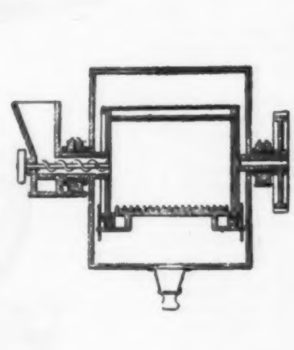


FIG. 5.

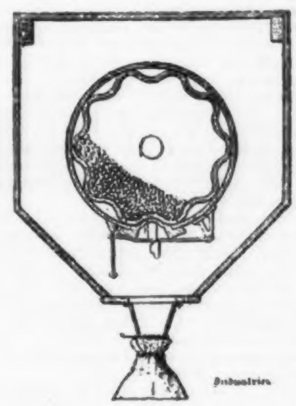


FIG. 6.

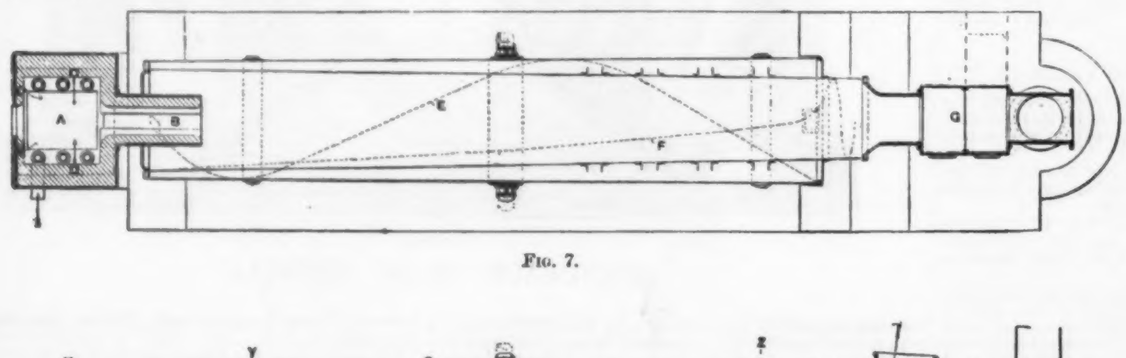


FIG. 7.

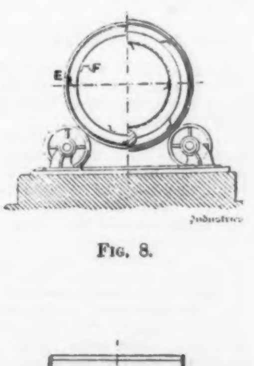


FIG. 8.

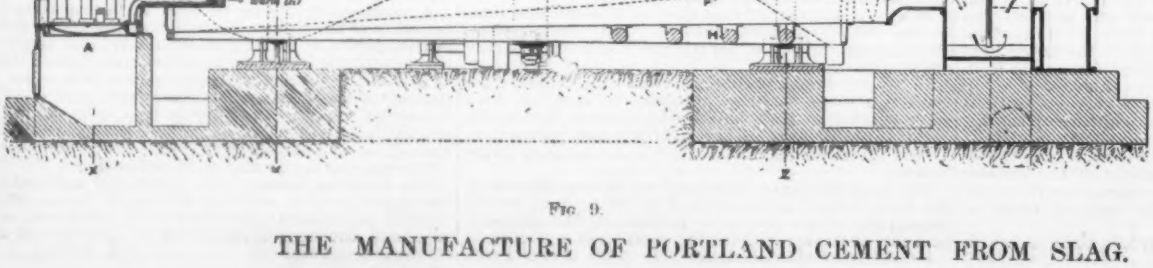


FIG. 9.

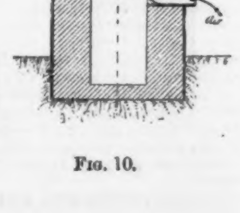


FIG. 10.

THE MANUFACTURE OF PORTLAND CEMENT FROM SLAG.

be completely slaked and in the form of a dry powder ready for mixing with the slag.

The granulated slag often contains from 15 to 30 per cent. of water, and before being used it is necessary to remove this water by drying. The simplest method consists in exposing the slag in a thin layer on a hot plate, and it is possible to dry completely 100 kilog. per square meter of surface per 24 hours in this way, with a consumption of 6 to 7 kilos. of coal. There is, however, a good deal of handling and labor attached to this method, and many processes are in use which are more or less continuous in action and more economical in labor and fuel. The drying apparatus devised by Ruelle, and used in France in the phosphate industry, has been used with success for drying granulated slag. We illustrate this apparatus (Figs. 7, 8, 9, and 10), which, it will be seen, consists of a long rotating cylinder containing the slag, and through which a current of hot air circulates. At A the air is heated, and at B it enters the cylinder, through which it is made to circulate by means of a ventilator. The rotating cylinder consists of two long slightly conical columns, about ten meters in length. The internal cone has its base nearest the fire, and is fitted with four helices, which regulate the motion of the slag within, so that it is uniformly exposed to the drying action of the hot air. The outer cone has its base away from the fire, and is supported at Y and Z, and within has four friction rollers on which the internal cone rotates. With this apparatus 25 tons of slag can be dried in 24 hours with an expenditure of 6 kilos. of coal per 100 kilos. of slag for heating the air and a motive power of 6 to 7 h. p. The apparatus, with ventilator, costs between £500 and £600. Other methods of drying the slag are in use at Choindez, in Switzerland, and at Saulnes, where recently M. Raty has erected important works for the manufacture of cement from slag. In the process patented by M. Raty the slag is granulated and dried in one operation. The apparatus is illustrated in Fig. 3. The slag, as it issues from the furnace in a molten state, flows down a metal channel, which is cooled by water (from T_2, T_4, and T_6) on the outside, and at the same time comes in contact with a small quantity of water (from T_1, T_3, and T_5) within. It will be seen that in this method the cooling must be so regulated that the slag becomes hard and granulated, and also sufficiently porous, before it reaches the end of the inclined plane, and at the same time must not prevent the evaporation of the water from the pores of the slag, so that it may be delivered in a dry condition on to the metallic running band. The length of the channel depends on the nature of the slag. M. Grosclaude, to whom we are indebted for this description, does not state whether the process is one which has come up to the expectations of the patentee. It seems to us that when once the proper dimensions for the successful delivery of the slag in a suitable condition for cement making at the bottom of the channel are obtained, the process should be one of great value, but we are unable to say whether the inventor is prepared to give data for these dimensions for varying amounts of slag. Fig. 4 shows a section of an air-drying arrangement in use at some works.

After the slag is granulated and dried, it is next ground to a fine powder in an ordinary mill. It is then ready for mixing with the requisite amount of dried slaked lime, which operation is effected in a specially constructed ball mill. We illustrate in Figs. 5 and 6 the mill, which is constructed by Luther, of Brunswick, for this purpose. It consists of a cylinder which can be rotated about a horizontal axis, and containing a large number of metallic balls about 25-35 mm. in diameter. The mixture of lime and slag is added by means of a screw feeder below the hopper. When the cylinder is nearly full, it is set in motion for about two hours, when the lime and slag are not only intimately mixed, but reduced to an exceedingly fine powder. By an opening in the side of the cylinder the contents can be emptied into a bag placed for the purpose, a grating preventing the metal balls from falling with the powder into the bag. Other mills for this purpose have been constructed by Thivet-Hauctin, of St. Denis. M. Grosclaude concludes his description by giving an estimate for the cost of erection of an installation for the manufacture of cement from basic slag. He estimates that to produce 20 tons a day, or 6,000 tons per annum, the necessary outlay in plant, consisting of a Ruelle drier, an engine of 150 h. p., a furnace, and all necessary mills, grinders, and mixers, as well as bags and barrels for holding materials and finished product, would be about £6,000. His estimate for cost of production, including, labor and fuel and interest on capital, is 18·584 fr. per ton of cement; but he further adds that this estimate is probably much too high, and states that in France, in those ironworks which have erected cement-making machinery for utilizing their slag, the cost of production does not exceed 12 fr. per ton. As the selling price of cement in France is about 35 fr. per ton, this shows that a considerable profit can be made out of this industry.—*Industries.*

LIGHT BATTERIES.

WE have already spoken of the light batteries employed by Commander Renard for the propulsion of the dirigible balloon La France, and we are now able to complete our data with exact figures upon the construction and operation of these apparatus, our information being obtained from an important memoir published by Commander Renard in the *Bibliotheque de la Revue de l'Aeronautique.*

The Renard batteries belong to the chromic depolarizing class, in which free chromic acid and hydrochloric acid, more or less diluted or mixed with sulphuric acid, are used.

Each element consists of a cylindrical ebonite tube, a platinized silver electrode 0·1 mm. in thickness, rolled into the form of a tube, and a non-amalgamated zinc cylinder of a diameter about one-sixth that of the vessel.

The complete substitution of hydrochloric for sulphuric acid has permitted of quintupling the specific power of the element. On making but a partial substitution of hydrochloric for sulphuric acid, we obtain attenuated liquids that give the same quantity of total electric energy, but with a specific discharge so much the smaller in proportion as the attenuation is higher.

Preparation of the Liquids.—The liquid may be prepared with pure or crystallized chromic acid or with commercial chromic acid. As the non-attenuated liquid is unstable and disengages chlorine, even at the ordinary temperature, it is prudent not to make the mixture until two days before it is to be used. Mixtures attenuated to 80 per cent. are more stable and can be prepared two or three months previous to use. All the liquids are prepared by mixing three elementary liquids in variable proportions.

Liquid A is a solution of chromic acid containing, per liter, 530 cubic centimeters of chromic acid and 770 cubic centimeters of soft water.

Liquid BCl is a solution of commercial hydrochloric acid made to indicate 18 deg. Baume.

Liquid BS is an aqueous solution of commercial sulphuric acid marking 29 deg. Baume (density 1·2515). It is obtained by mixing 450 grammes of sulphuric acid, of 66 deg. Baume, with 800 cubic centimeters of water. The mixture of the two latter liquids forms an intermediate

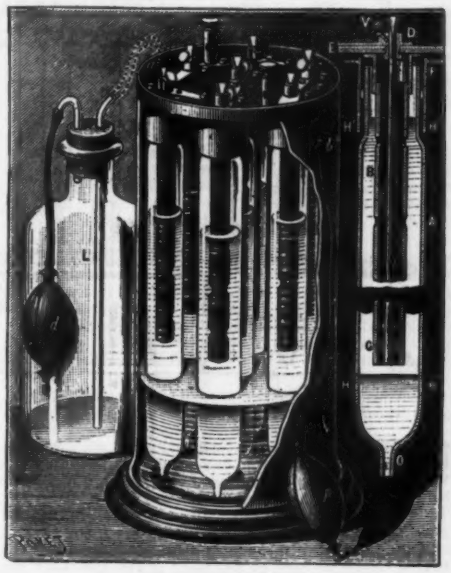


FIG. 1.—BATTERY FOR ELECTRIC LIGHTING.

A, elementary vessel; B, carbon; C, zinc; D, fastening of the zinc; V, binding screw; *b*, cock; H, level of the liquid in the large vessel; H', level of the liquid in the elements.

liquid called sulfo-hydrochloric, which is so much the richer in BCl liquid in proportion as one desires to obtain a greater specific power. The letter B, followed by an index, designates a mixture of the two last liquids containing one per cent. in volume of sulphuric solution shown by the index. Thus, for example, the liquid B 80 contains 80 volumes of liquid BS and 20 of liquid BCl. The figure 80 bears the name of degree of attenuation. The liquid used in the battery consists of equal volumes of the liquid A and a mixture of the two others.

Whatever be the degree of attenuation, the electric energy obtained per liter of liquid is sensibly the same. It varies between 50 and 60 watts-hour per liter. The duration of the discharge is more or less prolonged, according to the degree of attenuation. This attenuation may be obtained with other products, sulphate of

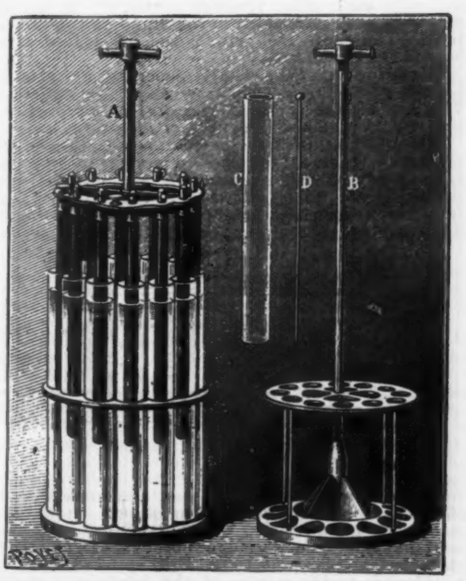


FIG. 2.—LIGHT CHLOROCHROMIC BATTERY.

A, collection of 12 elements, weighing 10 kilogrammes and having power of 220 watts; B, mounting of the battery; C, platinized plate of silver rolled into a tube; D, zinc.

soda, for example; but the specific energy is thus reduced. On arresting the discharge at the moment in which the intensity of the current falls to one-half of the maximum, we find that we obtain from 180,000 to 196,000 joules per liter of liquid, and from 144,000 to 158,000 joules per kilogramme. On endeavoring to increase the total electric energy, Commander Renard has devised a liquid that gives as many as 253,000 joules per liter, or 70 watts-hour, which would reduce the necessary volume of liquid to 14·5 liters per kilowatt-hour. But, as this liquid contains 100 grammes of CrO_3 and 200 cubic centimeters per liter, it has the drawback of being very dear and slightly viscid, and of making the zincs sticky. Practically, the best liquid is that which contains 200 cubic centimeters of HCl and 60 cubic centimeters of CrO_3.

Construction of the Battery.—The battery generally has the form of a cylinder of a length ten times its diameter. This form has the advantage of facilitating the cooling of the liquid, of diminishing the internal resistance, and of rendering the upsetting of the liquid more difficult. In the light batteries, the reservoirs are of ebonite. In the stationary ones, they are of glass or porcelain.

In the pneumatic battery, designed for lighting (Fig. 1), the elementary vessels, A, are sealed to the cover of a large, tight vessel, H, and the lower part contains an orifice, O, of small diameter. Upon forcing air into the large vessel or collector by means of a rubber bulb, *d*, or of a pump, the liquid is made to rise in all the elements at once. A cock permits of regulating the immersion of the elements, and, consequently, the internal resistance of the current. This arrangement is adapted to attenuated liquids only; with the normal liquid, the cooling would not proceed quickly enough. The vessel, L, and the bulb, *d*, serve to fill and empty the battery. The positive electrode of the light batteries (Fig. 2) is formed of a tube of platinized silver 0·1 mm. in thickness. The weight of the platinum on the two surfaces is about one-tenth that of the silver, and its thickness is about $\frac{1}{100}$ mm. The use of platinized silver greatly reduces the weight, the volume, and the internal resistance of the elements. On account of the high price of these electrodes, carbon is substituted for them in the batteries in which attenuated liquids are employed and in which lightness does not play an essential role. In order to facilitate the free circulation of the liquid, and to exhaust all the supply contained in the cylindrical vessel, the tube is split throughout its entire length to a width of a few millimeters.

The negative electrode consists of a cylinder of zinc or non-amalgamated zinc wire, whose diameter is about $\frac{1}{100}$ of that of the vessel, and is calculated to serve but once. This is guided and held in the center of the platinized silver tube by several disks of ebonite. Experience has demonstrated that in chlorochromic liquids ordinary zinc is not so readily attacked as amalgamated zinc as soon as the proportion of chromic acid exceeds 180 grammes per cubic centimeter of solution A. The amalgamation is costly and renders the zinc brittle, and its suppression permits of the use of lead in the pneumatic batteries. This could not be done with amalgamated zinc, for the drops of mercury, flowing accidentally over the lead, would soon perforate the envelope.

The discharge of a chlorochromic battery by no means presents the characters of that of a perfect one.

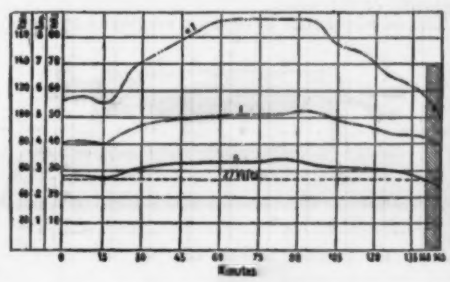


FIG. 3.—DIAGRAM SHOWING THE DISCHARGE OF A CHLOROCHROMIC BATTERY.

The variations in the temperature of the liquid, its alteration, and the diminution in diameter of the zinc during the discharge act so as to modify the constants of the elements at every instant. On another hand, the liquid of the battery exerts an important local chemical action entirely independent of the electric action, and in such proportions that it is necessary to always remove the zincs from the liquid when the battery is not in service.

If it is desired to exhaust the battery in a very short time, the local action, which is proportional to the time, will have a very slight influence, but the electrical rendering will be feeble; as the difference of potential at the terminals is low when the battery is giving a large discharge upon a circuit with hardly any resistance. If, on the contrary, the discharge is small, the electric rendering will be excellent, but the local action will then become preponderant, and will diminish the total rendering. It will be understood that between these two extremes there is a certain discharge which corresponds to the maximum rendering. Experience has demonstrated that such rendering is maximum when the difference of potential is from 1·20 to 1·25 volt per element, whatever be the temperature and the degree of attenuation of the liquids. This normal potential corresponds to a normal current which characterizes the element. This normal current is itself a function of the temperature. Thus, for a variation of 20° C., the intensity passes from 1 to 1·6 for the non-attenuated liquid and from 1 to 1·4 for the liquid attenuated to 80 per cent. So it is expedient to modify the degree of attenuation of a liquid with the temperature of the season. A liquid attenuated to 80 per cent., which is excellent during the summer, should be replaced by a 50 per cent. liquid for winter, when the battery is to be used for electric lighting.

The diagram in Fig. 3 represents the discharge of a battery of twenty-four elements in tension, containing in all 6·3 liters of liquid attenuated to 80 per cent. and discharged upon three Swan lamps of 27 volts and of from 1·25 to 1·30 ampere mounted in derivation. The curves show that the power, after a very marked syncope, at first increases regularly for an hour and a half, and afterward slowly decreases. At the end of two hours and twenty minutes, the electric power disposable is insufficient to supply the three lamps. It afterward falls very rapidly.

Taking, for a basis, the duration of two hours and twenty minutes, the total electric energy produced represents 547 watts-hour, say 55 watts-hour per liter. We can depend in practice upon 50 watts-hour per liter, say 20 liters per kilowatt-hour. Upon constructing the different parts of the battery with care, it is possible to produce apparatus that weigh but 30 kilogrammes

per electric horse hour, say 40 kilogrammes per kilowatt-hour, zincs included. By forcing the proportion of chromic acid, it has even been possible to obtain one horse hour for 25 kilogrammes, say one kilowatt-hour for 34 kilogrammes. With this rich liquid, a group of twelve elements, mounted by twos in tension and by sixes in derivation, weighed 10 kilogrammes along with the frame. Each of these groups was capable of discharging 22 kilogrammeters (220 watts) per second at the end of thirty minutes' operation, say 22 watts per kilogrammeter. Taking into account the performance of the motor, it required four such groups, weighing 40 kilogrammes altogether, to produce an effective power of one horse (736 watts) disposable upon the shaft. By reducing the dimensions of the elements, M. Renard has succeeded in constructing a battery of 36 elements, 20 millimeters in diameter, weighing 5 kilogrammes, and yielding as much as 0·5 horse for from twenty to twenty-five minutes, say 10 kilogrammes per electric horse, and from 25 to 30 kilogrammes per horse hour.

These figures establish the fact that chromochloric batteries are the lightest generators of electric energy now known. Despite the high price of the products used in them, they are capable of finding an application in all cases where lightness constitutes the main desideratum, such as in locomotion in general and aerial locomotion in particular, in rolling vehicles, and in small boats that have to make short trips at a high speed, in laboratory experiments, etc.

Commander Renard terminates his study with the declaration that electricity, even in this form, is incapable of leading to a solution of the problem of aerial navigation, for, in order to obtain a velocity of ten meters per second for one hour with a balloon such as La France, it would be necessary to carry along 1,000 kilogrammes of batteries, and this trip of an hour would still be insufficient from a practical point of view. However, in seeking a definite solution of the problem, it must not be lost sight of that the battery has rendered a great service to aerial navigation by permitting of making accurate measurements of the resistance of aerial keels in the air for the first time, and by victoriously demonstrating to the enlightened public that the research into the problem of the steering of balloons is not a Utopia.—*La Nature.*

INDUSTRIAL ELECTRIC OZONIZATION.

THE energetic oxidizing properties of ozone, its decolorizing power, its destructive action upon the germs of disease and of ferments, have for a long time attracted the attention of inventors to its applications, and a certain number of industries have thus been established. So we believe it well to call attention to the apparatus used or utilizable in the industrial preparation of this agent.

The ozonizers that have been employed or proposed

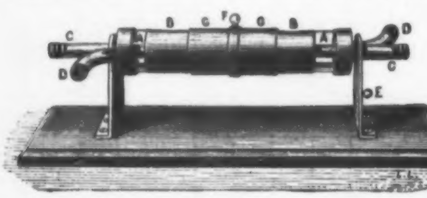


FIG. 1.

differ little upon the whole from those of the laboratory. There is always utilized in them the action of the latent discharge or of the rain of fire playing between two conductive surfaces placed a short distance apart. In certain ones, however, the brilliant spark produced by static machines is used.

Upon producing a discharge between multiple points, we obtain the brush, which is more favorable than the spark for good ozonization. Ducretet constructed a Holtz machine for the preparation of ozone upon the order of a chemist of Saint Gobain, Mr Girieud, who used it in experiments in the silvering of mirrors. The suction of air into the apparatus was produced by the centrifugal force of a wheel in motion. Hall has described an ozone generator formed, in the same way, of a Holtz machine inclosed in a glass cage. A ventilator placed upon the cage permits the air to enter. On setting the machine in operation, the air makes its exit sufficiently ozonized to be used for the disinfection of a hospital ward.

Among the ozonizers using the latent discharge, that of Eisenmann resembles in principle the Siemens tube. A Giffard injector sucks the air into the apparatus. Air ozonized in this way has been used for the purification of paints.

Static electric machines can be used for the production of latent discharges. The induction currents of the Ruhmkorff coil have almost always been employed.

Andrews has described a practical ozonizer of great power due to Beane, which again is a modification of Siemens'.

Tisley, of London, has described an ozone generator (Fig. 1) that permits of the refrigerating of oxygen submitted to the influence of the discharge through a current of cold water. It consists of a glass tube 35 mm. in diameter and 170 mm. in length, closed at its two extremities with copper, covered internally with paraffin or gum lac. Each piece of copper contains two apertures. A brass cylindrical box of a diameter a little less than that of the glass tube is placed in the interior of the latter. Two tubes fitted into the apertures in the copper hold it in a concentric position. The outside of the box is covered with tin foil, as is also the exterior of the glass tube. The gas to be transformed can be made to enter through the second aperture of each copper cap. Terminals communicate with the box and the tin foil. During the discharge, cold water is made to enter the interior of the box, where a system of small metallic plates containing apertures permits of the agitation of the liquid.

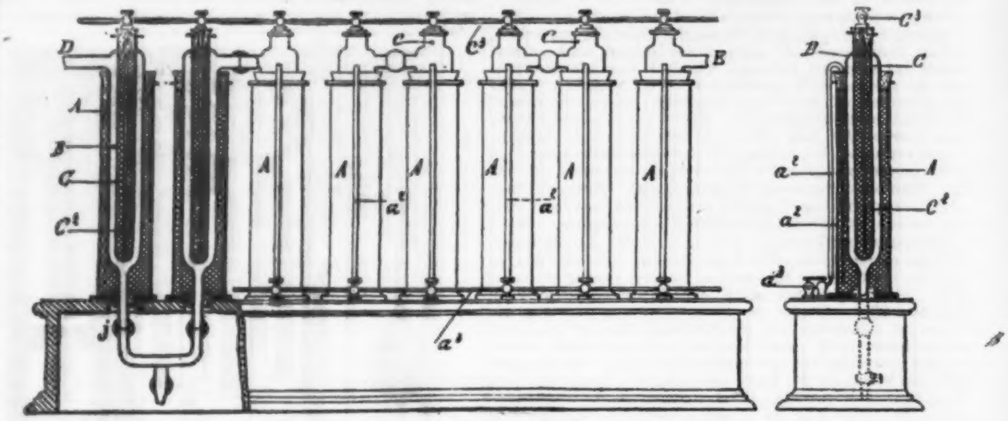
Wight, who has occupied himself with the applications of ozone, has described an ozonizer in vol. iv. (3d ser.) of the *American Journal of Science.*

The Brin Brothers have described an ozone generator, and we reproduce the same in Fig. 2. These gentlemen have discovered an economical means of extracting oxygen from the air, and it is by this process that the gas, compressed to 200 atmospheres, in steel cylinders, is now being daily delivered to commerce.

They have conceived the idea of giving their oxygen a new market by manufacturing ozone. The apparatus that they have constructed consists essentially of a series of eight systems of concentric tubes, in the annular space between which a current of pure oxygen circulates. As in laboratory ozonizers, each system presents two armatures, one of them internal and the other external.

An arrangement that we shall speak of further along permits of putting all the internal armatures in communication with one pole of a source of electricity, while the external ones are connected with the other pole.

The use of liquids (acidulated water, saline solutions,



FIGS. 2 AND 3.

sulphuric acid, etc.) for forming the conducting material of the armatures has been discarded. The inventors favor the use of solid conducting substances in fine and angular fragments and presenting points. This idea of points constitutes the originality of the Brin apparatus. As well known, the form of the discharge produced between points is the brush, and it is this brush or rain of fire that gives the best rendering in ozonization. Any sort of conducting substance may be used. Iron, zinc, and copper filings, plumbago (which had already been employed in the Boillot ozonizer), and lead dust have been tried in succession.

Figs. 2 and 3 show the arrangement of the apparatus, the first being a longitudinal section, and the other a transverse one. Fig 4. gives a plan view.

Upon a wooden box are arranged vertically, and in a row, a series of eight systems forming a battery of ozonizers. Each system consists of three concentric tubes, as in the Berthelot ozonizer. The central tube, C (Fig. 2), which is closed at one end and filled with filings, is soldered to the interior of a tube, B, of a slightly wider diameter. This tube is provided with a tubulure at the top and another at the bottom, enters the box that serves as a support, and communicates with the following ozonizer.

These two soldered tubes enter a cylindrical receptacle, A, filled with filings. It is in the annular space between the tubes, B and C, that the oxygen, entering through D, circulates in the apparatus. From the first ozonizer, it passes through the seven others, and makes its exit at E, where it is collected.

In the center of each central tube, C, there is a copper rod, C^2, fixed with cement. All these rods communicate with each other through a rod, C^3. A metallic rod, a^2 (Fig. 3), embedded in the filings of the external tube, A, communicates with a rod, a^3, placed at the base of the row of tubes.

The two poles of the electric generator are attached to each of the rods. The current of a magneto—or dynamo—electric machine, transformed by an induction coil, is what serves to run the apparatus.

An important question in this manufacture is that of joints. Ozone attacks most organic substances, and is destroyed by oxidizing most of the metals. India rubber is quickly perforated by it, and lutings of marine glue and red lead hold no better. In laboratories use is made of sealing wax, or, better, of a special wax

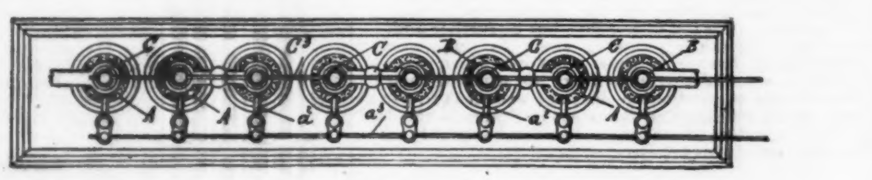


FIG. 4.

formed of gum lac and white wax, and known to physicists as Golaz luting. This substance, employed in joints, resists pretty well. Liquid joints of sulphuric acid may answer, as they are thoroughly tight. In the data that we possess as to the Brin apparatus, we find nothing as to the nature of the joints seen figured at *j.*

Ducretet has constructed a large ozonizer formed of a series of Berthelot tubes. The joints are made with sulphuric acid, and the discharge is made to pass in cascades.

An ozone manufactory has been in operation at Tournus (Saone-et-Loire) since 1887. The ozonizer used at the inception of the enterprise was Houzeau's, the armatures of which consist of two aluminum spirals, one of them external and the other in the interior of a glass tube in which oxygen is made to circulate.

This apparatus has been modified, in order to give the best rendering possible. Messrs. Broyer & Petit took three ozonizing tubes, arranged them in a line, and connected them by bent tubes, the whole being of glass in a single piece.

The oxygen gas traverses the three tubes. Each tube is arranged upon the circuit of an electric source. The electrification is effected separately. Each generator, at the beginning of the manufacture, consisted of two Bunsens and a small Ruhmkorff coil. At present, a small dynamo is employed, and derived currents are sent into the induction coils.

Ozone thus manufactured serves to purify low wines, and permits of rapidly improving and aging rectified spirits. The Teillard Society is putting brandies on the market that have the bouquet of old cognacs, and that are obtained by ozonization.

The rapid oxidation of ethylic alcohols and their homologues gives rise to the formation of sapid ethers, which give the aroma. Renard, in fact, has studied the action of ozone upon alcohols, and has shown that the latter are so much the more oxidizable in proportion as they contain less carbon and their atomicity is less elevated.

In order to succeed in aging brandy, it is necessary to use a relatively large volume of ozonized oxygen. With the above process it is necessary to employ a volume of gas about ten times greater than that of the liquid to be transformed.

In America, there have been industries in existence for some time that utilize ozone. Wideman in 1869, started a barley and corn whisky distillery, and, in order to remove the empyreumatic taste from his liquor, he uses ozone. In 1870 his Boston establishment was delivering to the trade 60 forty-gallon barrels per day of whisky thus improved.

In 1872, vinegar was manufactured by the action of ozone upon diluted alcohol. The alcohol brought to 7° or 8° acetifies, and at the above named period the White Plains (U. S.) works were daily producing more than a hundred gallons of vinegar. There are perhaps vinegar makers at Paris who use this process, for there are some who buy oxygen.

Maumene has made some experiments upon the decolorization of the saccharine juice of beets, and has found that ozone begins by decolorizing the juice without altering the sugar, and that an excess will produce introversion.

Brin has studied the same question, but we do not know whether the industry has derived any profit from his researches.

Andrews, in the discourse already cited, speaks of the applications of ozone made in the refining of sugar and bleaching of linen, without giving the source of his information.

But it is classic in chemistry to consider ozone as the decolorizing agent *par excellence.* It is this that acts in the old process of bleaching upon the grass, as well as in that of the hypochlorites.

Houzeau claims that ozone has a decolorizing power forty times greater than that of chlorine. However, this question of industrial bleaching by ozone, about which much has been said, has not been the object of serious studies, analogous to those of electrolytic bleaching.

There are other applications that have given results. An English manufactory of colorless varnishes has succeeded in obtaining these through ozone, and consumes a certain quantity of oxygen, that it transforms by discharges.

Ivory and ostrich feathers are decolorized in an atmosphere saturated with spirit of turpentine, and in the sun. Now we know that, in the oxidation of the turpentine, ozone is formed, and ozone alone has been employed for bleaching these materials. Old pictures that have turned yellow are made new by the action of ozonized air.

In 1886, Grognot pointed out a process of bleaching fatty matters melted and atomized by steam and ozonized oxygen. The patina of time is given to dyed woolens by means of ozone. The color lowers in tone, and new tapestries that imitate the old ones can thus be made.

Therapeutics has utilized ozone in certain affections. Hygienists have shown that it destroys the germs of disease, and this permits of using it as a disinfectant.

The applications made or to be made are therefore numerous, and are becoming of interest to electricians. We have recently read that an ozone manufactory has been established at Plaistow, England, and is in a condition to furnish ozone to the industries. It is even stated that it is capable of delivering it in a liquid form. It seems to us that liquefaction would be difficult to effect industrially, as a sudden compression decomposes ozone into oxygen.

It will be seen that there is an ozone industry that is bound to grow, now that electricity is produced everywhere and cheaply. We have thought it of interest to recall what has been done up to the present.—*La Lumiere Electrique.*

LIGHTNING OR OTHER HIGH TENSION CURRENT PROTECTORS.

By Prof. OLIVER J. LODGE.

THIS invention consists of a number of air gaps, connected to each other by coils or lengths of wire or other conductors, solid or liquid, which oppose the current either by self-induction or electro-magnetic inertia, or by resistance proper, and of either adjustable or fixed width. The apparatus to be protected, whether it be lamps or telephones, or telegraphic instruments or galvanometers, or meters or any other kind of electrical apparatus, is connected to the last air gap of the series; the line wire, or exposed leads or other wires, into which it is feared that lightning or high tension currents may possibly come, are connected to the first air gap of the series.

Fig. 1 shows the general arrangement of the invention, and Figs. 2, 3, 4, and 5, the practical method of applying the same.

In Fig. 1, A, B, are the terminals to be inserted in the leads, or between line wire and earth, etc. C, D, are the terminals to be connected to the instrument or thing requiring protection.

In Fig. 2, A and B are the terminals inserted in the leads, or A is connected with the line wire and B with earth; C, D, are terminals connected with the instrument to be protected, or C with the instrument and D with the earth, or C with the instrument and D left insulated as desired. E^1, E^2, etc., are air-gaps or insulating spaces. These can be formed with one or more points or rounded ends, as shown; or with knobs or plates or vacuum tubes or other suitable devices; G^1, G^2, etc., are self-induction coils, consisting, for instance, of guttapercha-covered wire coiled up on bobbins.

The action of the arrangement is as follows:

The ordinary currents, which it is intended to transmit through the apparatus to be protected, traverse the connecting wires or self-induction coils, G^1, G^2, etc., and do not jump any of the air gaps. But lightning, or any other foreign and violent currents which may accidentally have got into the leads, will jump one or more of the series of air gaps, and be thus diverted from the instruments or lamps to be protected.

Thus, the insulating spaces or air gaps may be arranged so that the greater portion of a violent discharge will jump the first, E^1; a certain fraction, say a tenth of the remainder, will jump the second, E^2; another fraction, say a tenth of this again, will jump the third, E^3, and so on; the amount finally permitted to go through the protected instrument being thus reduced to any desired amount.

It may be well to set the air gaps or insulating spaces of different widths; for instance, the first having broad rounded ends wider apart than the second, exposing larger surface and capable of easy examination and replacement (as by binding screw, *h*) in case of damage by a flash; the second having small rounded ends or points close together, and capable of minute adjustment by screwing up as shown, with lock-nuts, or equivalent device; the third still closer and finer, etc. It may also be well to vary the connecting coils, using thicker and more highly insulated wire for the earlier coils, and thinner for the later, as shown.

Fig. 3 shows a variation useful for protecting the insulation of covered wires or cables in which the exposed line is attached to terminal, A, and the protected one to C. B is connected to earth.

The first, F^1, is preferably a knob, plate, or rounded end, as shown, and of stout conducting material; the second and subsequent ones, F^3, F^5, etc., can be knobs or points, preferably the latter, and can be adjusted nearer the central knob, F^2, than F^1 is.

In Fig. 4, A is connected to the up-line wire, B to the down-line wire, C and D to all the instruments in the station, and E to the earth.

The conductor, K, connected with the earth, is placed between the entrance and exit wires, each of which is provided with a series of knobs, plates, or points (with self-induction coils between) forming air gaps with this conductor.

Fig. 5 shows an arrangement whereby existing protectors can be coupled up with resistances and other protectors in accordance with the invention. F and F^1 are the ordinary plate lightning protectors; F^2 and F^4 the well known tube lightning protector, in which a rod, F^4, is closely surrounded, but insulated from a cylinder, F^3, the one being on one line, the other on the other line. Either the rod or cylinder is usually studded with points almost, but not actually, in contact with the other, being separated therefrom by a thin stratum of air, a film of mica, or of other insulating material. F^5, F^6, and F^7, F^8, are lightning protecting devices, on the same plan as those in Fig. 2.—*Electrical Review.*

HISTORICAL NOTE ON THERMAL BATTERIES.*

By HENRI BECQUEREL.

IN the *Comptes Rendus* of the session of Feb. 17 last, Mr. Lucien Poincare presented an interesting note upon thermal batteries and the thermo-electric forces at the surface of contact between a metal and a melted salt.

This note opened as follows: "Voltaic elements can be formed by plunging two different metals in a melted salt brought to a temperature high enough for it to become a conductor. Up to the present no one has investigated the systems thus formed."

The systems in question, on the contrary, have long been put forth as possible sources of electricity; but as they appear, from this quotation, to be little known, I desire in a few words to recall them.

Electrical currents obtained by taking a melted salt as an electrolyte were investigated by my grandfather, A. C. Becquerel, over thirty-five years ago. The setting free of the electricity accompanied either combustion of the carbon or oxidation of different metals at the expense of the electrolyte.

One of the arrangements consisted of melting potassium nitrate in a platinum vessel and plunging therein a rod of carbon the point of which was brought to a state of incandescence. By another method, called a pyro-electric couple, two different metals, a bar of iron and another of copper, were plunged into melted silicate, *e. g.*, into a fused mixture of glass and carbonate of soda. At the ends of the two bars was obtained an electric current four times weaker than the current from a Bunsen battery. There was, therefore, an electromotive force of about one-half volt.

With these couples could be produced various sorts of electrolysis; the similarity to hydro-electric batteries was complete, and the author believed that the pyro-electric couples would serve to utilize furnace heat otherwise wasted.

In 1877 Jablochkoff again proposed the consumption of carbon in nitrates as a source of electricity.

In 1882 Brard published two notes on the subject, and constructed batteries in the form of bricks which, when placed in a fire, gave forth, while being consumed, a continuous current of electricity. This essay constitutes one of the most interesting efforts in the application of pyro-electric currents.

Finally, and quite recently, Messrs. Fabringi and Farkas, in 1888, presented to the Academy some modifications of the system proposed by Jablochkoff, intended to render the current more constant.

It is thus evident that this question has frequently attracted the attention of scholars and inventors. The efforts to obtain a practical application have mainly had in view the combustion of the carbon, whereas the important essay of M. Poincare, being entirely independent of previous work, applies itself directly to pyro-electric couples. It seems that these phenomena, according to the ideas of their discoverer, can become of important service in utilizing the heat now wasted in certain industries.

The furnace heat, in fact, is used only to keep the electrolyte in a liquid state; it is not transformed into electricity, so that a pyro-electrical apparatus placed in a furnace used for other purposes will not cause any additional consumption of combustibles. The economic production of electricity under these circumstances would depend simply upon the cost of the metals, salts, etc., from the chemical reaction of which is derived the current obtained.

* *Comptes Rendus*, t. cx., p. 444.

THE APPARATUS FOR ELECTRICAL EXECUTION.

So much has been said concerning and so many unauthorized and inexact descriptions have been published of the apparatus prepared for the first electrical execution, that a simple statement of the facts may be of interest to the readers of the *Electrical World.*

Of three equipments for killing by electricity procured by the State, the first to be employed is, as is well known, that at the Auburn prison; and to that particular case our description applies. The apparatus we may classify under three heads: first, the source of the electricity; second, the means for applying the electric current to the unfortunate prisoner; and third, the accessories that have been deemed desirable.

The dynamo at Auburn prison presents no startling or remarkable features—it is not a "whirling implement of death," but an ordinary alternating current dynamo, such as is generally used for incandescent lighting. Previous to its being purchased for its present unpleasant task, it was in use in Oneonta, N. Y. It is a Westinghouse machine of the pattern manufactured several years ago, and was designed to supply 650 incandescent lights. Like other machines of its class, its field magnets are excited by a small direct current dynamo, driven by a separate belt. The electromotive force of the large machine can be regulated nicely by varying the current supplied from this exciter. When both machines are driven at normal speed and the field magnets of the alternater are fully charged, the electromotive force across its terminals is considerably in excess of 1,000 volts. As arranged at Auburn prison, however, the alternater is driven at about 1,450 turns per minute, and the exciter at 2,100. Under these conditions the electromotive force of the alternater is reduced to 1,050 volts approximately. It should be remembered that this figure is the mean electromotive force, and that, as in all alternating current dynamos, the maximum voltage is considerably higher. If the varying voltage followed the theoretical curve exactly—a sine curve—the maximum would be 12 times the average voltage, which latter is alone referred to in estimating the commercial voltage of the machine. In the case of the dynamo under consideration the electromotive force fluctuates more sharply, however, and the maximum voltage is probably nearly or quite 2,000.

The current generated by this dynamo is taken to the execution room, and by pressing a simple button is connected to the electrodes. These are very simple in design. A rather flat cup of rubber, soft enough to admit of its edges yielding, and a little over four inches in diameter, contains the electrode proper. This consists of a thin circular brass plate, in diameter somewhat less than the cup. Upon this is fastened a layer of elephant's ear sponge to form the actual contact. A rod passing through the bottom of the cup carries the plate. A spiral spring inserted between plate and bottom of cup insures a firm contact when the cup is placed in position. The original plan was to apply the current to the head and feet of the condemned man, but that has been abandoned, and while one of the electrodes above described presses on the top of the head, the other is applied to the spine in the lumbar region, so that the brain and spinal cord are almost directly in circuit. The sponges on the electrode plates are of course wet, and holes in the rubber cups enable them to be filled with water if desirable.

As to accessories, the voltage produced by the machine is measured both in the execution room and dynamo room by Carden voltmeters placed each in series with a special resistance box. As the instruments are ordinarily constructed they do not measure potentials as high as 1,000 volts; thus extra resistance became necessary. As an additional precaution against doubtful voltage, and to serve as an indication that the apparatus is working in its normal way, a bank of twenty-four incandescent lamps is placed in parallel with the victim. These lamps can be successively thrown in series with each other by screwing them in their sockets with a turn or two. This arrangement gives an accurate idea of the total voltage across the mains, since the lamps require a known voltage, and instantly show any decrease by burning faintly. In case the voltmeters fail, as sometimes happens, these lamps are an excellent guide for adjusting the machine. An ammeter in circuit enables one to make a close estimate of the current actually used. Aside from the measuring instruments there is a pair of large switches insulated with extraordinary and needless care, one throwing the lamps into circuit, the other closing the circuit in the mains which lead to the electrodes.

Of the deadly nature of the combination there is not the slightest doubt, but it must be remembered that although the machine employed is similar to those in use for electric lighting, for electric execution the primary high potential current is used, while for domestic lighting the high potential wire is studiously kept out of houses, and the current actually passing through the lamps is from the secondary of a transformer and has a potential of but 50 volts, an amount which there is every reason to believe is entirely harmless. Even the primary current is practically no more dangerous than that used in ordinary arc lighting. Either will kill if given a fair chance, but both can easily be kept from becoming dangerous to the public.—*Electrical World.*

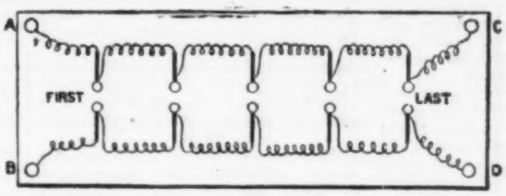


FIG. 1.

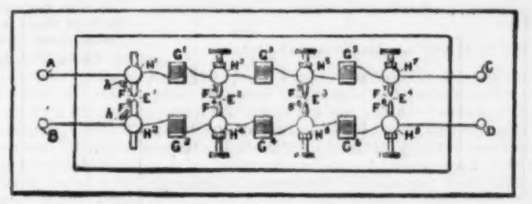


FIG. 2.

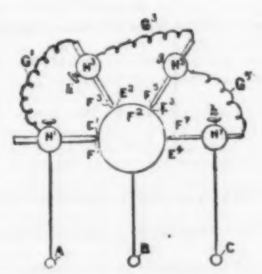


FIG. 3.

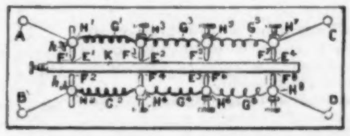


FIG. 4.

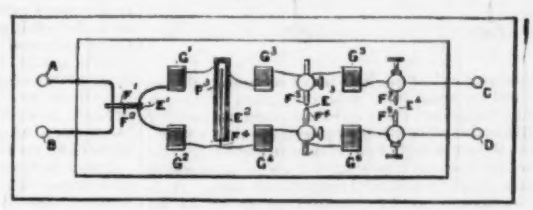


FIG. 5.

PEROXIDE OF HYDROGEN: ITS PRESERVATION AND COMMERCIAL USES.*

By C. T. Kingzett, F.I.C., F.C.S.

Peroxide of hydrogen is at once an extraordinary and a most interesting compound, extraordinary as regards the modes of its preparation and interesting on account of the facility with which it loses oxygen. It is this facility of decomposition which renders it so valuable as an oxidizing and bleaching agent, but at the same time has in the past militated against its more extensive adoption for such purposes. For a long time it has been recognized that if means could be devised of preserving this substance from spontaneous decomposition to any considerable extent, its market value would enormously increase, for while it is without rivals as an antiseptic oxidizing agent, it is also of a perfectly innocuous character and free from all objections. Peroxide of hydrogen has been with me the subject of much study, and, as is well known, I have for many years been engaged in the manufacture of compounds containing it or capable of yielding it in association with other substances under definite circumstances.

In connection with this part of my subject it may be mentioned by way of a summary statement that, when terpenes are subjected to oxidation by air, oxygen, or ozone, there is formed an active organic compound of the nature of a peroxide which remains dissolved in the hydrocarbons used for producing it, and when the product is placed in contact with water, peroxide of hydrogen is formed and passes into aqueous solution by some reaction of which the following equation may be accepted as giving, if not the actual reaction, at least an approximately correct representation:

$$C_{10}H_{16}O_4+H_2O=C_{10}H_{16}O_3+H_2O_2.$$

The compound $C_{10}H_{16}O_3$ (soluble camphor) is uncrystallizable and accompanies the peroxide of hydrogen in the aqueous solution.

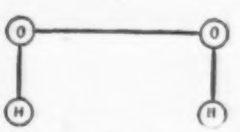
There is a great similarity between this chemical change and that by which the peroxide of hydrogen is made by the other well-known process, viz., by the action of dilute acids upon peroxide of barium. Taking sulphuric acid as representative of all acids, it may be said that when peroxide of barium is exposed to the presence of sulphuric acid and water, the following change results:

$$BaOO+H_2OSO_3=BaOSO_3+H_2OO.$$

It will be understood, of course, that I have here resorted to the use of somewhat abnormal formulæ in order to clearly represent what I believe to be the nature of the chemical change, and I have intentionally expressed peroxide of hydrogen by the formula H_2OO for reasons to which I am about to make reference.

The constitution of peroxide of hydrogen is generally graphically represented as follows:

Fig. 1.



which would signify that each atom of oxygen is diatomic, and is directly combined with one atom of hydrogen. But the character of the substance and its facility of decomposition are altogether opposed to such a view, and in a short paper which was communicated to the British Association some years ago† I gave expression to my opinion that in a strictly chemical sense it is rather to be regarded as oxygenated water or as an oxide of water. That is to say, oxygen is to be regarded as either a triad or a tetrad in valency, and the one atom is combined with the other which alone is directly combined with both atoms of hydrogen, thus:

Fig. 2.

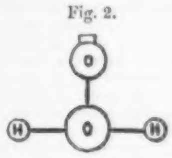
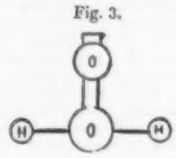


Fig. 3.



This view accords with the general sense of chemical opinion that when in a compound an atom of one substance is directly combined with another such atom, the combination is weak, and there is consequently facility of decomposition. This view is also supported by certain observations which were made by M. Berthelot, showing that when oxide of silver is placed in contact with peroxide of hydrogen, the amount of oxygen set free is only equal to that contained in the peroxide of hydrogen employed, the residual matter containing the whole of the silver and oxygen originally present in the oxide of silver, but redistributed, so that there results a mechanical mixture containing one-third of the silver in the reduced metallic state, and the oxygen, in combination with the balance, in the form of sesquioxide of silver. To put the matter in another way, the chemical change is not to be expressed by the equation:

$$H_2O.O+Ag_2O=H_2O+Ag_2+O_2,$$

but rather by this one:

$$3H_2O.O+3Ag_2O=3H_2O+AgO_3+Ag_2+O_3.$$

Further confirmation is lent to my views by the very existence of ozone, which may be viewed as a form of triatomic oxygen.

To pass on now to the chief part of my subject, it should be first stated that, while peroxide of hydrogen is undoubtedly very prone to suffer decomposition, the statement which is made in most text books, to the effect that dilute solutions are immediately decomposed on ebullition, is radically wrong. It is, therefore, all the more to be regretted that this method has been advocated for estimating the strength of the liquid. As a matter of fact, dilute solutions may be concentrated by evaporation, although, of course, there is an attendant loss of oxygen.

Mr. G. E. Davis at one time* published some figures illustrating the rate of decomposition of a solution of peroxide of hydrogen, but before reproducing these it may be as well to explain the meaning of a description which is common enough in commerce. I refer to the strength of such solutions as expressed in volumes. A 10-volume solution of peroxide means a solution which is capable of yielding of itself, by perfect decomposition, ten times its own volume of gaseous oxygen at the ordinary temperature and pressure.

Now Mr. Davis worked with a 10-volume solution, so that 100 cc. yielded 1,000 cc. of oxygen when fully decomposed; in other words, the solution contained 3·04 per cent. by weight of real peroxide of hydrogen, and was capable of yielding 1·43 per cent. by weight of oxygen gas.

On	Aug.	2,	1878,	the strength	of	the solution	was	9	volumes.
"	"	9	"	"	"	"	"	8·4	"
"	"	24	"	"	"	"	"	8·0	"
"	Sept.	1	"	"	"	"	"	7·9	"
"	"	24	"	"	"	"	"	7·8	"
"	Oct.	24	"	"	"	"	"	7·2	"

I shall presently furnish other figures from my own experience, but may at once state that the rate of decomposition is by no means constant. It varies with the temperature, exposure to light, and the impurity of the solution. Sometimes a solution will be found to suffer even less change than that observed by Mr. Davis, while at others it undergoes complete decomposition in course of a few weeks, and more or less suddenly. The observations I have made will serve to explain to some extent the reasons for this capricious character.

To those engaged in the manufacture of peroxide of hydrogen it is well known that the presence of a little ether restrains the decomposition, and, indeed, in his experiment, Mr. Davis found that by adding a little ether to the solution on October 24 it had not deteriorated in strength two months later in the year. The action of the ether is not, however, always to be depended upon, and its presence is apt to lead to danger, particularly if added to solutions which are likely to be exported to hot climates, while it is sometimes objectionable on other grounds also. I have suggested that the restraining influence of ether is to be found in the fact that it also generates peroxide of hydrogen by atmospheric oxidation. It may also act by reason of its volatility, thus generating a vapor which exercises a gentle restraining pressure over the solution.

Dr. G. Gore has shown, in a paper recently communicated by him to the Royal Society, that when chlorine water is exposed to light, the chemical changes that occur in one distinct period result in the production of hydrochloric, hypochlorous, and chloric acids, and that at a later stage a further formation of hydrochloric acid takes place, while at the same time peroxide of hydrogen is formed in solution. Under the influence of prolonged sunlight, the whole of the oxygen of the hypochlorous and chloric acids united with water to form the peroxide, and that substance subsequently entered into combination with the whole of the hydrochloric acid and formed a definite "solution compound" which is represented by the formula $2HCl,H_2O_2$. This is the more interesting because it is well known that, as a bleaching agent, chlorine acts intermediately by the decomposition of water, and it is nascent oxygen that is credited by chemists with the bleaching effects thus attainable. It is, after all, not impossible that the effects are due to the formation of peroxide of hydrogen, a substance which is, as a bleaching agent for woolen and some other goods, rapidly displacing bleaching powder in public estimation.

I now propose to call attention to the decomposition and preservation of peroxide of hydrogen as influenced by the presence in it of other substances in a state of solution.

I may premise that I was led to this investigation by my desire to put upon the market a series of disinfectant solutions for use by surgeons and others which should be characterized, in common with "Sanitas" disinfecting fluid, on the one hand by the presence of a definite quantity of peroxide of hydrogen and on the other hand by containing a definite amount of some one or other of a series of reliable antiseptic and germicidal substances.

Some medical men prefer one antiseptic and others exercise other selections, but I insist upon the necessity of using any such germicides, in association with a potent oxidizing agent, capable of chemically destroying the toxic products which result from the growth of bacteria and other micro-organisms in suitable media.

It is these toxic products that are more to be dreaded than the micro-organisms themselves, and no system of disinfection is perfect, from a chemical point of view, which overlooks the necessity for their chemical change or destruction.

After surmounting many difficulties, into the details of which I need not enter here, I was faced with what proved to be the greatest obstacle of all, viz., the liability of such solutions, when prepared, to undergo decomposition, and that sometimes with almost explosive violence.

As I felt that there was no royal road to success, and no scientific clew to a means of overcoming the trouble, I determined to study the matter in a constructive sense, and to ascertain, over long periods of time, the preservative or destructive influences which might be exercised by dissolving, in solutions of peroxide of hydrogen, definite percentages of various substances, and the results which have been tabulated for convenience this evening represent some of the results.

In this series of observations, 50 cc. of peroxide of hydrogen solution was used in each experiment, the solution being of such strength that 100 cc. was capable of liberating from an acidified solution of potassic iodide such an amount of iodine as required 730 cc. $\frac{N}{10}$ hypo. solution ($Na_2S_2O_3$) to decolorize it.

0·5 gramme of the several substances indicated in the first column was added to as many quantities of the peroxide. The mixtures were placed in well-stoppered bottles freely exposed to the light of the laboratory, and the strength of the solutions in terms of cc. $\frac{N}{10}$ hypo. was determined as above explained from time to time.

The experiments were started on the 30th of November, 1887.

TABLE I.

Name and Amount of Substance added.	Original Strength of the H_2O_2 Solution in Terms of cc. Hypo. per 100 cc. on Nov. 30th, 1887.	After 20 Days.	After 62 Days.	After 176 Days.	Loss.
5 Per Cent.					Per Cent.
Standard ...	730 cc.	730	706	586	20
K_2SO_4		710	690	562	23
Na_2SO_4		720	706	592	19
$(NH_4)_2SO_4$..		720	704	586	20
$MgSO_4$......		726	508	146	80
$FeSO_4$		46	42	26	96
$Al_2(SO_4)_3$ ...		688	592	274	62
$HgSO_4$......		660	442	94	87
$CuSO_4$		158	74	52	93
$ZnSO_4$		704	576	292	60
$MnSO_4$......		574	338	54	92
KNO_3......		730	706	618	15
$NaNO_3$		730	718	616	15
NH_4NO_3....		730	708	594	19
$Ba(NO_3)_2$...		724	712	610	16
$Sr(NO_3)_2$ ...		736	724	630	14
$Ca(NO_3)_2$ ...		724	716	600	18
$Mg(NO_3)_2$ ..	730 cc.	734	716	608	17
$Fe(NO_3)_2$...		52	36	[illegible]	97
$Cu(NO_3)_2$...		226	83	54	93
$Zn(NO_3)_2$...		726	60	38	95
$Pb(NO_3)_2$...		714	570	254	65
$Hg(NO_3)_2$ ..		726	670	46	94
KCl		710	702	606	17
NaCl		722	668	393	46
NH_4Cl......		724	713	618	15
$BaCl_2$.......		712	720	630	14
$SrCl_2$.......		724	714	610	16
$CaCl_2$		740	724	620	15
$MgCl_2$.......		722	710	620	15
Al_2Cl_6.......		524	228	44	94
Fe_2Cl_6		68	54	53	93
$CuCl_2$......		82	74	76	90
$PbCl_2$.......		692	484	84	88
$SnCl_2$.......		648	642	562	23
$ZnCl_2$.......		720	718	544	25
$HgCl_2$		724	712	606	17

From a study of the results it will be seen that none of the substances which were tested materially promoted the stability of the peroxide, although several nitrates and chlorides exercised a limited restraining influence. It will be further seen that very many of the added substances materially facilitated the decomposition of the peroxide.

In the somewhat disjointed series of observations next to be described, and the results of which are expressed in Table II., the substances indicated in the first and second columns were added to so many solutions of 100 cc. each, except in the case of chloroform, in which 50 cc. of peroxide was employed, together with the amount of absolute alcohol, as indicated for the purpose of dissolving the added chloroform.

The original testings of the solution are expressed in the table. The solutions containing the added substances were placed in stoppered bottles and gently shaken from time to time.

It will be seen that one standard solution did not suffer any decomposition in the course of thirty-one days, while in another instance a standard solution suffered change to the extent of nearly 16 per cent. in twenty-nine days; a third standard solution lost 74 per cent. in twenty-two days, and the whole of its H_2O_2 within eighty-four days; in the fourth series of observations the standard solution lost 95 per cent. in thirty-six days. The rule was that, the greater the warmth of the weather, the greater was the loss in a given time.

It will also be observed that alcohol, glycerine, chloroform, absolute phenol, ether, acetic acid, and potassic bisulphate exercised a restraining influence.

The next series of observations, which are tabulated in Table III., were based upon the results of the preceding experiments, and were at once more systematic and much more extended in point of time, lasting over 405 days, so far as the results now communicated are concerned, while some of the solutions are even yet in course of observation.

One per cent. by weight in volume of the added substance was employed, and the observations were commenced on August 28, 1888. Originally 100 cc. of the H_2O_2 which was employed required 1,296 cc. $\frac{N}{10}$ hypo. solution.

The testings were made by taking out 5 cc. of the solutions, making up to 50 cc. with added water, and using 5 cc. of the diluted solution for the purpose of decomposing acidified KI solution, after which the iodine set free was determined in the usual manner.

The phenol, beta-naphthol, and thymol mixtures all became discolored (brown), the last named one being least discolored.

* A paper read before the Society of Chemical Industry, London, January, 1890.

† See *Chem. News*, vol. xlvi., p. 141.

* *Chem. News*, vol. xxxix., p. 221.

The original solution of peroxide was exactly neutral, but gave a precipitate with solution of barium chloride.

The following substances were imperfectly dissolved: β-naphthol, thymol, and salufer.

The results speak for themselves, and it is only necessary to point out the very distinctive value of the following substances in restraining the decomposition of the peroxide, viz., alcohol and ether.

Many other of the added substances were more or less effectual, in common with which it is seen that sulphuric acid was of some value.

On April 14, 1889, a fresh series of observations were made, using a solution of peroxide of hydrogen which was slightly acid to test paper.

With sulphuric acid it gave a slight precipitate of sulphate of barium.

With barium chloride it did not yield a precipitate. Ammonia caused in it a flocculent precipitate, which was to a large extent soluble in ammonium chloride. With hydric-disodic phosphate it gave a slight precipitate. By way of strength, 100 cc. liberated such an amount of iodine from acidified potassic iodide as required 1,540 cc. $\frac{N}{10}$ hyposulphite of sodium for complete reaction.

Quantities of 100 cc. each were taken, and to them was severally added 1 gramme of the substances indicated in Table IV.

Again, it will be observed that alcohol and ether each materially preserved the solutions of peroxide of hydrogen from decomposition. So also did camphoric acid, camphor and menthol, while thymol, the influence of which is very comparable with that exhibited in the previous series of experiments, comes out better in comparison with all these substances.

The observations which are still in hand have not extended, however, over such a protracted period as those which are expressed in Table III.

Viewing the whole results of the third and fourth series of observations, it is perhaps to be inferred that the comparative success attained in the third series was due to the employment of an *exactly neutral* solution of peroxide, for although sulphuric acid exercises a restraining influence on its own account, it facilitates decomposition in comparison with the repressive action of ether, alcohol, thymol, camphoric acid, camphor, and other substances.

It was upon the basis of these and other results of a like character, and having regard to the mode of preparation of the crude article, that I have been enabled to devise satisfactory means for preserving peroxide of hydrogen as presented in commerce from any appreciable loss of strength over reasonable periods of time.

It remains for me to state that these means have been patented, and none of the substances which I have indicated as being useful for repressing the natural decomposition of peroxide or for preserving it from such change can be employed by others than the Sanitas Company, limited (to whom I have assigned my rights), or their licensees.*

In those cases in which it has been ascertained that certain substances facilitated the decomposition of peroxide of hydrogen there is a great range of activity, and in the operations of bleaching these facts admit of practical utilization.

As a rule, some alkaline compound, such as ammonia or carbonate of sodium, is used to promote the operations, but they act too violently and cause much loss of oxygen, thus adding to the expense of the process. For many such purposes, therefore, these alkaline compounds may in future be well replaced by some of the compounds referred to in my tables, and of which borax affords a striking example.

Apart from the previously well-known oxidizing properties of peroxide of hydrogen, it was proved for the first time by some experiments, of which an account was presented by me to the British Association in 1876, that this substance exhibits striking antiseptic effects, and is capable, even when present in very small proportions, of entirely arresting processes of fermentation which are originated by living organisms. The antiseptic properties of the substance were subsequently confirmed by the observations of Guttmann and Froenkel in Germany. Later still, some similar observations were made by M. Baldy, who concluded that peroxide of hydrogen is in no respect inferior to carbolic acid.

M. Paul Bert and M. Regnard confirmed my own earlier experiments, they showing (*Comp. Rend.*, 94, 1383–1386) that an extremely dilute solution of peroxide of hydrogen prevents the fermentation of glucose by the agency of yeast, prevents mycodermic growth in red wines, lactic fermentation in milk, and the putrefaction of albumen, etc.

On the other hand, they found that it was incapable of arresting the changes which are induced by soluble non-organized ferments, such as diastase. This distinction is of importance, because if peroxide of hydrogen be employed for internal administration, it affords a guarantee that the presence of that substance in the human system will not arrest nor interfere with the many assimilative and other processes which are carried on by means of ferments of the pancreatic type.

It was therefore to be expected that this compound would be found of peculiar benefit for the treatment of wounds and for general use in the practice of antiseptic surgery, and that anticipation has been amply realized in the practice of M. Baldy and M. Regnard, and particularly that of M. Pean in the hospital of St. Louis.

It has been demonstrated beyond question that all wounds which are treated with peroxide of hydrogen progress well, healing by first intention, all discharges being healthy in character and free from odor. Chronic ulcers are similarly treated with the same successful results, so also cases of gangrene, fetid suppurations, and bad ozenic discharges.

M. Pean performed many important operations in an atmosphere impregnated with peroxide of hydrogen instead of carbolic acid, and M. Baldy employed gauze and wool which had been soaked in peroxide for placing in contact with wounds by means of bandages where prolonged contact was desirable. He also found that it might, with safety, be used as an injection for washing out cavities.

* See this journal, 1889, p. 1000; and 1890, p. 101.

TABLE II.

Name of Substance introduced.	Percentage of same.	Orig. Testings.	On 29th Day.	On 63rd Day.		Percentage of Loss.	—	—		—
Standard	..	870	733	674		22	..	.. ..	..	
Alcohol (proof spirit).	5 cc. = 2½ per cent. real alcohol.	822	716	756		8	..	.. ..	..	
Glycerin	2½ per cent.	856	730	746		13	..	.. ..	..	
Standard	..	738	686	.. ..	..	7	..	.. ..	..	Started April 13, 1888
Borax	5 per cent.	710	80	.. ..	..	89	..	.. ..	..	
Hydrochloric acid	15 cc. solution (containing 33·8 per cent. real HCl).	660	156	.. ..	..	76	..	.. ..	..	
Chloral	5 per cent.	718	626	.. ..	..	13	..	.. ..	..	
Oxalic acid	5 "	714	278	.. ..	..	61	..	.. ..	..	
			On 31st Day.							
Standard	..	724	732	.. ..	..	0	..	.. ..	..	
Sulpho-phenic acid	5 per cent.	628	686	.. ..	..	0	..	.. ..	..	Started April 17, 1888.
Boric acid	5 "	712	572	.. ..	..	20	..	.. ..	..	
			On 22nd Day.	On 53rd Day.		On 84th Day.	On 182nd Day.	Percentage of Loss.		
Standard	..	794	206	20		0	..	100		
Sodium benzoate	5 per cent.	614	34	Discontinued.		..	..	100		
Chloroform and alcohol.	5 cc. chloroform and 50cc. abs. alcohol.	742	742	734		694	660	11		Started June 5, 1888.
Borax neutralised with boric acid	5 per cent.	724	32	Discontinued.		..	..	100		
Absolute phenol	5 "	816	752	680		558	480	41		
			On 36th Day.	Percentage of Loss.	On 67th Day.	Percentage of Loss.	On 110th Day.	On 165th Day.	Percentage of Loss.	
Standard	..	786	22	97	0	100	0	..	100	
Potassic chlorate	5 per cent.	846	66	92	50	94	0	..	100	
Ether	5 cc.	798	688	14	666	16·5	700	640	19·8	Started June 22, 1888.
Acetic acid (glacial)	5 cc.	794	746	6	698	12	660	620	21·9	
Caustic potash	5 per cent.	782	32	96	14	98·2	0	..	100	
Potassic bisulphate	5 "	796	778	2	738	7·2	740	680	14·5	

TABLE III.

Name of Substance added. (1 per Cent. in each Case.)	cc. Hypo. required per 100 cc. 28th Day = Loss.	Per Cent.	Hypo. required on 44th Day = Loss.	Per Cent.	Hypo. required on 98th Day = Loss.	Per Cent.	Hypo. required on 202nd Day = Loss.	Per Cent.
Standard A. No addition	1,160	10	1,140	12	940	27·4	790	30·0
Standard B. H_2SO_4 on 46th day	1,180	9	1,140	12	1,000	22·8	938	27·6
Ethylic alcohol	1,280	1	1,300	0	1,200	7·4	1,198	7·5
" ether, sp. gr. 720	1,340	0	1,320	0	1,240	4·3	1,264	2·4
Methylated chloroform, sp. gr. 1·498	1,240	4	1,240	4	1,120	13·5	1,038	18·3
Acetic acid (congeals at 50°)	1,300	0	1,340	0	1,180	8·9	1,148	11·4
Glycerin, sp. gr. 1·260	1,260	3	1,260	3	1,140	12·0	1,064	17·9
Phenol, pure cryst. P.B.	1,180	9	1,200	7	1,060	18·2	1,035	20·1
Beta-naphthol, cryst.	1,140	12	1,160	10	980	24·3	894	31·0
Chlorol, P.B., pure cryst	1,280	1	1,340	0	1,120	13·5	1,039	20·5
Thymol	1,220	6	1,240	4	1,120	13·5	1,085	16·2
Phenylacetic acid	1,300	0	1,350	0	1,180	8·9	1,170	9·7
Sulpho-phenic acid, cryst	1,260	3	1,260	3	1,200	7·4	1,170	9·7
Boric acid	1,060	18	980	24	800	33·2	590	54·4
$KHSO_4$	1,240	4	1,220	3	1,080	16·6	1,120	13·5
KCl	1,100	15	1,060	18	800	38·2	690	46·7
Na_2SO_4	1,140	12	1,120	13	900	30·5	800	38·2
$NaNO_3$	1,340	0	1,120	13	880	32·1	790	39
$NaC_2H_3O_2$	100	92	60	95	Discontinued.			
$BaCl_2$	1,080	16	1,040	19	800	33·2	710	45·2
NaCl	1,160	10	1,120	13	880	32·1	785	39·4
$HgCl_2$	1,200	7	1,200	7	900	30·5	725	44·0
Salufer	1,220	6	1,180	9	920	29·0	742	42·7
Standard A. No addition	520	59·8	340	73·7	220	83·0	140	89·2
Standard B. H_2SO_4 on 46th day	800	38·2	680	47·5	513	60·4	410	68·3
Ethylic alcohol	1,260	2·7	1,140	12·0	1,020	21·2	1,000	22·8
" ether, sp. gr. 720	1,320	0*	1,200	7·4	1,100	15·1	1,090	15·9
Methylated chloroform, sp. gr. 1·498	940	27·4	760	41·3	568	56·1	Discontinued.	
Acetic acid (congeals at 50°)	1,060	18·2	900	30·5	642	50·4		
Glycerin, sp. gr. 1·260	820	36·7	580	55·2	366	71·7		
Phenol, pure cryst. P.B.	920	29·0	860	33·6	715	44·8		
Beta-naphthol, cryst	Discontinued.							
Chloral P.B., pure cryst.	760	41·3	520	59·8	366	71·7		
Thymol	900	30·5	840	35·1	696	46·3		
Phenylacetic acid	980	24·3	940	27·4	770	40·5		
Sulpho-phenic acid, cryst	960	25·8	860	33·6	752	41·9		
Boric acid	Discontinued.							
$KHSO_4$	800	38·2	680	47·5	532	58·9		

* The results given in the two last columns have been added since the paper was read.—*Author.*

Dr. A. W. Harlan, in a paper read before the American Dental Society (*Dental Record*, November, 1882), strongly recommended the use of peroxide in the treatment of blind alveolar abscesses and pyorrhea alveolus, because the rapid evolution of oxygen gas effects a thorough evacuation of the pus without creating any undesirable after effects.

M. Landolt, of Paris, and Dr. J. E. Adams, of the London Hospital and Royal London Ophthalmic Hospital, have both used peroxide of hydrogen with great

TABLE [illegible]

Solution. (1 Per Cent. of added Substances.)	Testings after 43 Days, viz., on May 27, 1889.	Percentage of Loss.	Testings after 97 Days, viz., on July 20, 1889.	Percentage of Total Loss.	Testings after 176 Days, viz., on Oct. 7, 1889.	Percentage of Total Loss.	Testings after 270 Days, viz., on Jan. 9, 1890.*	Percentage of Total Loss.
H_2O_2 only (white bottle)	1,131	23	700	54	435	71·7	370	75·9
Large ditto (blue bottle)	1,377	10	890	42	610	60·4	530	65·5
Methylated ether, sp. gr. 720	1,443	6	1,410	8	1,330	13·6	1,280	16·8
Chloroform, sp. gr. 1·498	1,302	15	850	44	565	63·3	Discontinued.	
Ethylic alcohol, P.B.	1,490	3	1,370	11	1,225	20·4	1,180	23·3
Glacial acetic acid	1,330	11	1,120	27	990	30·6	Discontinued.	
Glycerin, sp. gr. 1·260	1,424	7	1,020	33	595	61·3	Discontinued.	
HNO_3	1,292	16	740	51	415	73·0	Discontinued.	
H_2SO_4	1,406	8	990	35	690	55·2	Discontinued.	
Sulpho-phenic acid	1,207	21	1,020	33	855	44·4	Discontinued.	
Phenylacetic "	1,415	8	1,170	24	942	38·8	Discontinued.	
Salicylic "	1,245	19	1,010	34	810	47·4	Discontinued.	
Camphoric "	1,538	0	1,420	8	1,255	18·5	1,180	23·3
Thymol	1,538	0	1,460	5	1,355	12·0	1,300	15·5
Camphor	1,500	2	1,410	8	1,260	18·1	1,260	18·1
Chloral hyd. P.B.	1,330	13	850	44	473	69·1	Discontinued.	
Menthol	1,538	0	1,400	9	1,275	17·2	1,220	18·8
Nicotine	1,085	29	840	45	705	54·2	Discontinued.	
$NaHSO_4$	1,340	12	810	47	500	67·5	Discontinued.	
$KHSO_4$	1,339	13	830	46	540	64·9	Discontinued.	
Creosote	1,330	13	1,200	22	1,105	28·2	Discontinued.	

* The results in these two last columns have been added since the paper was read.—*Author.*

success in cases of purulent discharge from the conjunctiva (see *British Medical Journal*, December 9, 1882).

Since October, 1885, Professor Hofmooke has employed peroxide with the greatest advantage in the treatment of diphtheria, while for syphilitic and cancerous swellings and wounds generally it is now in everyday use by many of the most eminent surgeons at home and abroad.

In a recent paper (read before the Kings County Medical Association, February 5th, 1889, during a discussion on diphtheria : see *Gaillard's Medical Journal* for March, 1889), Dr. E. R. Squibb, of Brooklyn, says : "If diphtheria be at first a local disease and be auto-infectious, that is, if it be propagated to the general organism by a contagious virus located about the tonsils, and if this virus be, as it really is, an albuminoid substance, it may and will be destroyed by this agent upon a sufficient and sufficiently repeated contact."

Peroxide of hydrogen never fails to thoroughly cleanse all mucous surfaces. It not merely exhibits the power of destroying pus and other such products by oxidation, but it is admitted by the most reliable bacteriologists to be an exceedingly powerful germicide, ranking perhaps in this respect next to biniodide of mercury, while, as distinct from that substance, it is quite non-poisonous.

As all air-breathing animals depend upon atmospheric oxygen for their very life, it stands to reason that, for all diseases that are in any way dependent upon defective oxidation, peroxide of hydrogen is the best natural remedy, being a solution of oxygen in chemical combination with the elements of water.

Valuable as is peroxide of hydrogen alone, it becomes still more valuable in its properties when associated with other reliable antiseptics and germicides as presented in the series of bactericides to which I have made general reference in an earlier part of this paper.

With respect to the uses of peroxide of hydrogen for bleaching, a summary statement will suffice. It has been used and is being used with success for bleaching wool and woolen goods, silk (particularly tussah), ostrich feathers, living and dead human hair, sponges, ivory, bone, wash leather, horn, gut, wooden articles, and so forth. It may also be employed for bleaching cotton, fine yarns, and textiles, but not so successfully as for woolen goods. For such bleaching purposes tanks or vessels of wood, glass, or earthenware are employed. Metallic vessels have to be avoided. The general method of procedure consists in freeing the articles from dirt and grease by washing them with ammonia water or with dilute soda or carbonate of soda, and after having thoroughly rinsed them out they are immersed in the solution of peroxide of hydrogen, sometimes used of 10-vol. strength and at other times of only 2-vol. strength ; frequently ammonia or some other alkali is added to the solution of peroxide in order to facilitate the bleaching.

The operation of bleaching is generally carried out at a temperature of about 30°-50° C., heat being employed in the form of steam carried through a leaden coil immersed in the bath.

As I have previously pointed out, the addition of an alkali in order to hasten the effect is made at the expense of using an extra amount of peroxide, and in my opinion borax would replace it to advantage where it is necessary to employ any such agent for facilitating the operation.

DISCUSSION.

The chairman said that the practical application of peroxide of hydrogen depended in very many cases on the possibility of retaing the solution at approximately the same strength for a considerable period. Every chemist knew, however, that under ordinary circumstances it was a most unstable body. The restraining action on the decomposition of hydrogen peroxide exhibited by the various substances mentioned by Mr. Kingzett was extremely curious and surprising. He would have expected that the more unstable the associated body, the more rapid would be the decomposition of the peroxide of hydrogen ; but this had proved to be by no means the case. The useful adaptation of oxygen depended, broadly speaking, on the careful study of the conditions of its activity, and everything which threw light upon that important subject was of the highest scientific and industrial value.

Prof. Clowes said that the paper had suggested one or two points of theoretical importance upon which he would be glad to have some further information. It was well understood that the valency attributed to the atom of a chemical element was disputable, and therefore he was not surprised to find suggestions for altering the valency of oxygen. But Mr. Kingzett had assumed apparently that it might be either triad or tetrad instead of dyad. Probably he had already assigned his reasons for that assumption, but if he could now give them again, members of the section would probably be glad to hear them. He (Dr. Clowes) did not understand how the oxygen atom could be represented as triad in the molecule of ozone. In the table written on the blackboard, too, Mr. Kingzett indicated the change occurring between hydrogen peroxide and silver oxide, and introduced the formula AgO_3. He would be glad to know whether Mr. Kingzett had any definite grounds for assuming the existence of that unfamiliar substance.

Dr. Squire had at one time had a great deal to do with hydrogen peroxide, and found that, provided that it were properly made to begin with, ether preserved it very well, in fact, left nothing to be desired. But there was peroxide and peroxide, and these remarks applied only to a tolerably pure article. The amount of ether required was small, about one ounce to the gallon being sufficient to preserve the peroxide for six months at least. At all events, peroxide so preserved was sold under the name of Robare's Aureoline in thin flat glass bottles, which would burst with the slightest internal pressure, and in this form remained for months in hairdressers' shops with perfect safety. In what way the ether acted, he did not know ; certainly not, as Mr. Kingzett suggested, in consequence of its vapor exercising a certain pressure. If a slight pressure were all that is required, this would be supplied by the partial decomposition of unprotected peroxide in closed vessels. The pressure thus produced ought to stop further action, but this was not found to be the case. In reference to the author's remarks as to the strength of the solution, he would point out that it was not only in America that a five-volume solution of hydrogen peroxide was sold as 10 volumes. By treatment with permanganate or bichromate of potassium 10 volumes were obtained, of course, but half of it came from the decomposing agent and the other half from the peroxide itself. He believed that by the universal custom of the trade the label 10 volumes meant evolving, not containing, 10 volumes.

Dr. Steinhart wished to know whether Mr. Kingzett had tested his solutions to which alcohol had been added and whether the latter, in the presence of so powerful an oxidizing agent as peroxide of hydrogen, had not been oxidized to aldehyde, and finally to acetic acid. It was well known that an acid solution was more stable, and it occurred to him, therefore, that the stability of the author's hydrogen peroxide in this case might be due to the presence of acetic acid and not to the alcohol.

Dr. S. Rideal thought it would be interesting to be able to compare the different monetary values of oxygen, free and combined. He would therefore ask the author to give the meeting, if he could, some data as to the monetary value of oxygen as an oxidizing agent. They would thus be able to judge whether bleaching as performed by hydrogen peroxide would be cheaper or dearer than when due to bleaching powder or other oxidizing agent.

Mr. Kingzett, in reply, said that the reason he had represented oxygen as either triatomic or tetratomic was that it could not possibly be diatomic. If it were diatomic, the two oxygen atoms in the peroxide of hydrogen molecule would be equally associated with each atom of hydrogen, and consequently of equal stability, which was not the case, seeing that one atom only was so easily dissociated. Chemical common sense clearly showed that the two atoms could not have the same combined value in peroxide as the one atom of oxygen had in a molecule of water. It followed, therefore, that it must be either triatomic or tetratomic. He inclined to the view that it was triatomic, because it undoubtedly was so in ozone. As to the chemical equation on the slate which had been referred to in course of the discussion, he wished to disclaim all responsibility for it. It was due to the French chemist, Berthelot, and represented the analytical results of his investigation as communicated to the *Academie des Sciences.*

Dr. Squire's remarks were especially valuable, because of his large experience in the manufacture of peroxide of hydrogen ; and he had hit the right nail on the head when he said that the action of the ether depended largely upon how the hydrogen peroxide itself had been prepared. Therein laid the crux of the matter. If it were carelessly prepared, if it were either acid or alkaline in character, or if it contained certain impurities, no agent would prevent it from decomposing within certain limits ; but if it were properly prepared, as it could be by those who understood the subject, then the substances which he had mentioned were capable of preserving it from material loss of strength for 12 months or more. With respect to the strength of hydrogen peroxide solutions, he knew that there were manufacturers here dishonest enough—he used the term advisedly, for it was dishonesty—to represent that their five-volume solutions were 10-volume solutions, relying on the quantity of oxygen as obtained by the so-called permanganate test. In America they always did so ; but of course that could be got over by testing the solution with acidified iodide of potassium, and estimating the iodine thus set free in the usual manner.

Mr. Steinhart had inquired as to the specific chemical action of alcohol, and had suggested that the stability of the peroxide, as preserved by that substance, was due to the formation of acetic acid and the production thereby of an acid reaction. That could not be, for if Dr. Steinhart would refer to Table III he would find that in the first two experiments (which were made with standard solutions) he had added 1 per cent. of sulphuric acid to one of them on the 46th day, and it would be seen that the restraining influence of the acid reaction was expressed by the fact that on the 405th day the unprotected solution had lost 83 per cent. whereas the protected solution (which for 46 days was maintained under the same conditions) had, owing to the addition of the sulphuric acid, lost only 60 per cent. Therefore the restraining action of the sulphuric acid was about 23 per cent. It would also be seen from the same table (experiment No. 6) that acetic acid certainly exercised an even greater restraining influence than sulphuric acid ; so much so, that on the 405th day the loss was only 50 per cent. Therefore it had a greater effect *per se.* Whether the effects of the sulphuric and acetic acids were to be regarded as due merely to "acid reaction," or were to be viewed in their individual characters, there could be no question but that alcohol certainly restrained very much more than did either the one acid or the other, as was revealed by the figures submitted. It was, therefore, absolutely incredible that the preservative effect of alcohol is due to the generation of acetic acid therefrom.

Lastly, as to the monetary value of oxygen in its various forms, he was sorry not to be able to give any exact data. Air was cheap enough, but it was not capable of producing those decolorizing and oxidizing effects which had to be obtained in the commercial bleaching of silk, cotton, paper, bone, hair, etc. Atmospheric oxygen, therefore, had no value in relation to such applications, nor was pure oxygen any more valuable, so far as he knew. Hydrogen peroxide, and that alone, had a distinct value for such purposes. Common air and oxygen were of no utility either for antiseptic purposes, whereas peroxide of hydrogen had a most pronounced value in that respect.

With regard to bleaching powder, he had stated in his paper that peroxide of hydrogen was, so far as Germany and France were concerned, believed to be rapidly replacing bleaching powder for bleaching woolen, silk, and other goods, partly in consequence of the destructive effect of chloride of lime on the tissues of such materials, and also because peroxide of hydrogen gave better results. He believed that the adoption of peroxide would follow more largely in England in time; and as to the comparative cost, the results which had been published justified him in saying that peroxide of hydrogen was not more expensive than bleaching powder for such purposes, while its production was constantly being cheapened and its effective action increased.

ANALYSES OF SOME AMERICAN FIRE CLAYS.

	1	2	3	4	5	6	7	8
Silica	50·46	44·95	50·15	45·42	46·90	60·97	61·02	59·60
Alumina	35·90	37·75	35·60	36·80	39·60	26·38	25·64	26·41
Water	12·74	13·05	13·01	12·65	13·80	8·93	9·68	10·48
Potash	traces	......	......	......	......	......	0·48	0·29
Soda	......	0·98	0·07	......	0·17	0·82	0·25	0·16
Lime	0·13	0·30	0·11	0·87	......	0·85	0·70	1·00
Magnesia	0·02	0·21	0·16	0·45	......	0·03	0·08	0·07
Oxide of iron	1·50	2·70	0·83	3·33	......	1·46	1·70	1·61
Oxide of manganese	traces	......	......	0·48	......	......	......	......
Sulphuric acid	......	0·07	0·14	......	......	......	......	......
Bisulphide of iron	......	......	0·06	......	......	......	......	......
Sulphur	......	......	......	......	......	......	0·45	0·38
Total	100·75	100·01	100·70	100·00	100·47	99·64	100·00	100·00

1. Mount Savage fire clay, by Prof. J. M. Ordway, Massachusetts Institute of Technology.
2. Fire clay, Sandy Ridge, Center county, Pennsylvania, Andrew S. McCreath.
3. Fire clay, mine at Clearfield, Clearfield county, Pennsylvania.
4. Fire clay, Johnstown, Pennsylvania. Analysis by T. T. Morrell.
5. Kaolinite scales, Tamaqua, Pennsylvania (mean of two analyses purified by chlorohydric acid). Preliminary report on the mineralogy of Pennsylvania, by F. A. Genth, Second Geological Survey of Pennsylvania.
6. Fire clay, of Charles Frost & Co., Winchester, Illinois. Analysis of Chauvenet & Blair, St. Louis, Missouri.
7. Fire clay, Cheltenham, Missouri (crude). Analysis by Prof. A. Litton.
8. Fire clay, Cheltenham, Missouri (washed). Analysis by Prof. A. Litton.

FEODOSSIEFF'S NEW METHOD OF TEMPERING AND HARDENING STEEL FOR CANNON AND PROJECTILES.*

By WATSON SMITH, F.C.S., Lecturer in Chemical Technology in University College, London.

PROFESSOR W. C. ROBERTS-AUSTEN, in his very able lecture before the British Association at Newcastle-on Tyne, last year, pointed out the confusion at present existing in the use of the words "hardening," "tempering," and "annealing" as applied to steel. He gave the following definitions. Hardening is the result of rapidly cooling a strongly heated mass of steel; tempering, that of reheating the hardened steel to a temperature far short of that to which it was raised before hardening—this heating being followed or not being followed by rapid cooling; while annealing consists in heating the mass to a temperature higher than that used for tempering, and allowing it to cool slowly. As I shall hereafter show, the method to be described can either be used for hardening steel or may be modified for tempering or annealing. This method has been invented by Captain G. Feodossieff, of the Imperial Russian navy. Glycerine is the substance or medium used, and it is employed for the tempering or hardening of steel, cast steel, or cast iron. It is proposed to vary the specific gravity of the glycerine from 1·08 to 1·26 at 15° C. by the addition of water according to the composition of the steel and the effects desired. The quantity of glycerine is to be from one to six times greater in weight than that of the pieces to be plunged into it, and in accordance with the hardness of the metal, its temperature is to be varied from 15° to 200° C., a higher temperature being employed for the tempering of the harder steels, while a lower temperature is used for tempering the milder steels. Additions of various salts to the glycerine baths are recommended to increase their quenching power. Thus, for a hard temper, manganous sulphate may be added in quantity varying from 1 up to 34 per cent. of the liquid, or from ½ to 4 per cent. of potassium sulphate; for a softer temper, 1 to 10 per cent. of manganese chloride and 1 to 4 per cent. of potassium chloride. The principal advantages claimed for these processes are as follows:

1. The temperature of the aqueous solutions of glycerine may be varied within wide limits, the boiling point of pure glycerine being 290° C.
2. Owing to the fact that solutions of glycerine in water dissolve most salts that are soluble in water, the quenching powers of the glycerine may be readily varied by dissolving such salts in the bath to suit the kind of metal to be tempered and the degree of temper required.

It will be observed that in the directions given in the patent just those are defined which are necessary for the manufacturer or workman who already possesses a general knowledge of the subject of hardening and tempering. However, since the date of this patent, Captain Feodossieff writes me that he has made new and further improvements, and has succeeded in tempering heavy projectiles, armor plate, and railway tires by his glycerine process, and has obtained very satisfactory results. I have now much pleasure in exhibiting some specimens of steel treated by Feodossieff's process. The first is a 4 inch cast steel ingot which had been made red hot and then immersed in glycerine. An examination of the upper part of it will show that a peculiar shrinkage has taken place, which proves that the metal has not been forged. This ingot, sent me by Captain Feodossieff from St. Petersburg for exhibition with the other specimens at this meeting, was specially sent for the purpose of showing us that the qualities of the metal are derived from the manner of hardening, and not from forging. Specimen No. 2 is a part of the same ingot as No. 1, but which has been forged, raised to a low heat, and then plunged into glycerine. After cooling, it was bent at an angle of 180 degrees. The tensile strength of this piece of annealed steel is 65 tons, elongation 15 to 18 per cent. The specimen before us was bent cold. Specimen No. 3 is of forged steel, tempered in glycerine. All three pieces now exhibited, Nos. 1, 2, and 3, are fragments of the same 4 inch ingot. With regard to specimen No. 2, which was bent upon itself cold, analysis proved it to have the following composition: Carbon, 0·7 per cent.; chromium, 2·2 per cent.; silicon, 0·15 per cent. Captain Feodossieff has experimented with unforged cast steel 12 inch projectiles. One of these penetrated 12 inch armor plate made by Cammell; the head part of the projectile fell at 10,000 feet behind the target. He now makes 12 inch projectiles which penetrate 16 inch armor plate. Various experiments have proved that Feodossieff's method of hardening produces an intrinsic change in the molecular structure of the metal.

The inventor proposes that experiments should be made now with guns, which are so difficult to forge; but such experiments ought to be made on a large scale, in works like those of Lord Armstrong & Co., Elswick, or of Sir Joseph Whitworth & Co. I need hardly point out the great importance of this suggestion, if it should be found that, by such a uniform method of treatment, the absolute uniformity of structure of the strongest and toughest kind so much desired in large ordnance will be insured, and that thereby, as one would *a priori* conclude, a great decrease in the cases of the bursting of cannon be the result, or that such cases be reduced to as nearly zero as possible. When one thinks of the operation of forging, it is difficult to believe that, even with the best mechanical contrivances, the result can be absolutely uniform in all parts of so large a piece of metal as that serving for the construction of a large piece of cannon. If not uniform, we must expect to have strong and also weaker places. When it comes to a process of treatment by immersion in a liquid like glycerine, it becomes then difficult to discover why a uniform process with uniform results should not be attainable.

DISCUSSION.

The chairman (Mr. David Howard) said that the subject of the tempering and hardening of steel was one of those obscure questions, lying on the border land of chemistry and physics, which recent discoveries had thrown some light on, but which were still most difficult to deal with. The consideration of how far this particular process was likely to be successful in overcoming the difficulties of the problem he must leave to those members, several of whom were present, having that special experience which would enable them to decide.

Mr. A. H. Allen found it difficult to understand why there should be any great difference in the behavior of steel when cooled by immersion in glycerine and when cooled by immersion in oil, which was the ordinary method of proceeding. He would have expected that all that was required was a viscous liquid with a high boiling point; and that so long as the necessary condition of viscosity or mobility was secured, it would not matter much whether the steel was hardened in glycerine or oil, or other suitable liquid. He desired to protest against what he considered a misuse of the term tempering. He understood Mr. Smith to use that term to express the process of dipping or immersing the hot steel in glycerine or other liquid with a view to produce a hardening effect. It was usual, however, to restrict the term tempering to that softening by moderate heating which was carried out after the hardening—to reduce the hardness. It might be that the tempering or softening process was prevented from going too far by again immersing the steel in water or other liquid, but this could not be considered essential, except in a supplementary sense, and was not tempering. If the author had made his steel as hard as he could by sudden cooling, and had then heated it up in glycerine, instead of relying on the film produced on the surface or other indication that the requisite temperature had been attained, that might have been called tempering. As used in the paper the term was likely to cause confusion, and he hoped, therefore, that Mr. Smith would modify his use of it before it was printed.

Mr. Watson Smith desired to remind the meeting that, in communicating Captain Feodossieff's results, he was in a position of some difficulty, especially with respect to the terms employed. For that reason he had begun the paper with the definition of hardening and tempering given by Professor Roberts-Austen. He was at a loss to know how he could, with propriety, make any radical alterations in Captain Feodossieff's own statements.

Mr. Bertram Blount thought that some attention should be paid to the fact that the steel treated by the author of the paper was not of normal composition, but contained chromium. Reference to the peculiar properties of such steels had been made by Mr. Arnold, Sheffield, in a paper read before the Institution of Civil Engineers last year, on the subject of the use of steel for railway tires. Mr. Arnold had, if he remembered rightly, found that for making a steel moderately hard, and free from tendency to failure, it was safer to use chromium than to increase the percentage of carbon. But such a steel as that could hardly be compared with ordinary steel. Another point that had occurred to him was that these highly conductive—or rather high boiling point—liquids, though distinctly of use, should not be necessary in the hands of any workman of ability. It had been said that a man who could not temper steel with fire and water merely ought to abandon the trade.

Mr. Jos. Bernays said that he had had some experience in the hardening and tempering of steel. The tempering could be done in various ways; and he agreed with Mr. Smith's definition of it as a slighter reheating of the steel, and plunging it into a liquid. The process was so carried out in every smith's shop in the making of tools and similar articles of steel.

They were first heated and made thoroughly hard; then they were heated again to a lower temperature, and were then again plunged into water for thorough cooling. He would not say that tempering might not be done in other ways; but the method he had described was the one usually followed in an engineer's shop. He had done the operation frequently himself, and had by it produced a proper temper in steel tools, springs, etc.

Mr. A. H. Allen inquired which operation was considered by Mr. Bernays to be tempering—the warming up after hardening or the plunging into water afterward?

Mr. Bernays replied that both were necessary, that the steel was first heated to redness, and plunged into cold water or oil for making it hard. It was, however, not quite cooled down. The inside of the steel was left hot, and a bright spot was then filed at the part to be tempered. As the surfaces were getting reheated from the inside, the bright part assumed various colors, first pale straw, then pale blue, and lastly dark blue, according to the heat transmitted from the interior. As soon as the right degree was arrived at, the steel was again plunged into water and thoroughly cooled, and was then in the condition of tempered steel.

Mr. Allen asked whether the last operation was considered essential for any purpose besides getting the metal cooled quickly and conveniently. Mr. Bernays said it was necessary to prevent the metal getting still hotter.

Mr. Allen feared that Mr. Bernays and he were speaking of different things. Mr. Bernays was probably referring to large bodies of metal, whereas he was considering small articles, in which case any final artificial cooling to prevent spoiling of the temper already attained was unnecessary.

Mr. Bernays replied that he was speaking of articles of the size of the samples before them, which had a considerable thickness. They might be reheated in a different way, by bringing them to an external source of heat.

Dr. Squire wished to point out, with respect to Mr. Allen's remark, that the process described in the paper was not under the same conditions as the method of tempering by means of oil. There was a difference which might perhaps be of importance. The specific heat of glycerine was higher than that of oil; and, moreover, he understood the author to say that the glycerine might be mixed with more or less water, by which its specific heat would be further increased. The greater the specific heat of the liquid into which the steel was plunged, the more rapid would be the cooling; so that the dipping into glycerine more or less diluted appeared to be a sort of half-way method between dipping into water and dipping into oil.

Mr. Allen said that was true.

Mr. E. Riley said that Mr. Hadfield, who was present, would probably be able to tell the meeting something about the effect of adding chromium to steel. He might say, however, that its use had been known for twelve years past. Hundreds of tons of chromium iron had been used for making axles at Messrs. Brown, Bayley & Dixon's works because it was found that the addition of a little chromium pig to the steel enabled it to stand a very severe falling weight test. That was in 1878 or 1879, and the fact was then a trade secret.

Mr. R. A. Hadfield feared that he could not give the meeting much information as to the effect of chromium on steel. His own experiments indicated that the combination of chromium and iron only did not give hardness, and that the prevailing impression that they did was a wrong one. Carbon alone seemed capable of giving the hardness to iron, that is, to the material termed steel; and unless carbon was present, chromium was no more effective than manganese, silicon, or other element. Perhaps it might be well for the author to know that the results he had quoted as to tests of projectiles were very different from those required by our own war office. A 12 inch shell penetrating a 16 inch plate would not be considered sufficient by our government. They would require it to pierce something like 20 inches of compound steel and iron plates—which was a severe test. Thanks to the assistance which the government was now giving to English manufacturers, they were accomplishing similar results, equal and superior to those of foreign makers.

A short time ago, his firm (Hadfield's Steel Foundry Company) had sent two 6 in. shells through 9 in. compound plates and 8 feet into the wood backing, and both shells were practically undamaged. It was satisfactory to know that his own firm and other English makers had been able to fulfill the requirements of the war office, and equal foreign productions. There was considerable misconception as to the definition of the word tempering.

He thought that Mr. Allen was perfectly right in his view, and that the hardening must be defined as a distinct process, and not mixed up with tempering. Probably the error was partly explained by the fact that the French always use the word "tremper" to indicate hardening; thus the English and French expressions had got mixed and led to this prevalent misconception. Hardening, he thought, must be defined as the turning of the carbon from the state in which it was found in unhardened metal into the hardened compound, in which form it would scratch glass; if this result was not attained, then the term hardening could not be applied. Tempering in all Sheffield trades meant a subsequent and separate operation or reheating and reduction of hardness. The form of that compound was not known at present, but thanks to the experiments of scientists much was being found out about it. In the meantime it would be best to stick to the good English word hardening, which clearly defined the operation. Tempering was a different process altogether.

Mr. E. Riley quite agreed with Mr. Hadfield as to the effect of chromium. His firm had used it in the manufacture of soft steel, because it was found that it increased the tensile strength of the metal without increasing its hardness. It was expensive to use, however, and his firm did without it as far as possible.

Mr. R. A. Hadfield said that it was a striking instance, showing how men's minds in different parts of the world unconsciously worked on the same idea, that experiments had been made in America within the last two years in the same direction as the process now described by Professor Smith.

* Paper read before the Society of Chemical Industry (London Section), February 3, 1890.

A NOVEL SEESAW.

WE saw the apparatus represented herewith passing along the boulevards during mid-lent. It was fixed

NEW GYMNASTIC APPARATUS.

upon a carriage, and much amused all those who saw it operate. We have thought it would prove of interest to our readers if we described it.

The apparatus, called the "Aerial," was invented by Mr. Serie, professor of gymnastics, and constitutes a hygienic and recreative means of exercise. When a person has taken his place upon the seat, he can, by properly regulating the counterpoise, describe the circle indicated by the dotted lines, and, in the apparatus designed for adults, may, at a certain moment, find himself elevated fifteen feet in the air.

By accustoming himself to exercising with the apparatus, a person can overcome vertigo and become dexterous and bold, and strengthen his chest.

It is expressly recommended to follow these directions: (1) Place the apparatus exactly perpendicular and upon as level a surface as possible. (2) Upon taking a seat, see if you are in perfect equilibrium with the counterpoise. If not, slide the weight in one direction or the other until an equilibrium is established. (3) When you wish to set yourself in motion, separate the stopping levers, and, bending the legs, place the toes upon the floor, and afterward straighten the legs progressively. This slight impulse of the hams will suffice to raise you into space and make you describe an arc of a circle of about three-quarters of a revolution. On coming back to the starting point, place the feet upon the floor and proceed as before.

It is expressly recommended to leave the seat only on the side of the levers, after taking care to fasten these latter in the arms of the balance. Finally, never seesaw without being well balanced, and never under any pretext add an additional weight to the counterpoise of the apparatus.—*Les Inventions Nouvelles.*

PHARMACEUTICAL MEETING.

AT a recent pharmaceutical meeting, Philadelphia College of Pharmacy, specimens of white turpentine and resin were presented by Mr. R. G. Dunwody, the beautiful quality of which was commented on; the resin was in cubes of about an inch. In reply to a question whether it was put on the market in this shape, it was explained that from each lot of resin, as run off into barrels, a quantity was run into a narrow trough of an inch depth and width, and this was broken into the small cubes as samples by which each lot could be sold.

Mr. G. E. Robeson, representing Dodge & Clark, of New York, presented a specimen of "Musc Baur," an artificial substitute for musk with an odor of very strong resemblance to that of the genuine article. The substitute is claimed to be three times as strong as grain musk.

Dr. C. B. Lowe presented two small oranges preserved in alcohol, known in Florida as *kumkuats*. They are about the size of walnuts, and taste much like the larger fruit. They are used as a table decoration in some places.

Mr. Beringer exhibited some pieces of porcelain apparatus, made at the Royal Porcelain Works, in Berlin. It consists of a funnel with finely perforated diaphragm for filtering off liquids where it is desirable to preserve the precipitate. Another apparatus consists of a perforated plate with ring and cover, and in the side of the ring a perforation, to which the exhaust of a filter pump may be attached, so as to secure rapid filtration; to tighten the joints between the various pieces, a piece of dampened filter paper may be laid between the plates, thus forming a close joint.

Mr. Beringer exhibited a sample of leaves of *Papaver somniferum*, which had been imported presumably for use in wrapping around opium after it had been partially deprived of its morphine. As opium must have a certain percentage of morphine to pass the Custom House inspection, it was thought that the opium, after being imported and partially exhausted, might be put up into balls with poppy leaf wrappers, like the foreign opium; and it was stated that a Turk, skilled in the manipulation of opium, had been brought to this country. Prof. Maisch said that under former rulings of the Treasury Department, Persian opium was not permitted to be imported except for the manufacture of morphine, and then under a bond that it should be so used; that variety of opium reaches our market packed in poppy trash, and not wrapped in poppy leaves and packed in rumex capsules, like the Smyrna opium. Boston or so-called pudding opium was stated to be quite common in the New England market, of definite quality, and is said to have been prepared at the suggestion of Boston importers, and made into small balls for convenience. Prof. Maisch exhibited from his cabinet some varieties of Constantinople opium in small balls about 2 to 5 ounces weight.

A paper upon tartaric acid was read by Mr. Fred. H. Smith, of the present class. Prof. Maisch read a letter from Mr. G. A. Krauss, giving some further information in addition to that contained in his thesis of 1889, upon villosin, a product from *Rubus villosus*, discovered by him. Specimens of white crystallized villosin and villosic acid, made by Mr. Krauss, were also exhibited.

Mr. Dunwody read a paper on *krameria*. Prof. Maisch asked whether the percentage of tannin found was not considerably lower than that previously determined by Wittstein. Prof. Trimble suggested that Wittstein may have had a fresher sample for his examination; thus, geranium, while fresh, contained a larger percentage of tannin than after drying and when the tissues had become red. Mr. Beringer exhibited samples of the Brazilian and Peruvian krameria root examined by Mr. Dunwody; the last named sample, Prof. Maisch said, was less scaly, much thinner, but cleaner and of handsomer appearance than the commercial article of 25 or 30 years ago.

A paper upon morphine salts and hydrocyanic acid was read by Prof. Maisch, and several specimens of morphine solutions made in various ways were exhibited. The solution in distilled water, to which hydrocyanic acid had been added, remained clear; likewise a solution in bitter almond water, the latter having been prepared by dissolving oil of bitter almond directly in water. Mr. Beringer showed a solution of morphine sulphate in imported cherry laurel water, which had deposited a crystalline sediment. On testing the cherry laurel water he had found it to contain magnesia and to yield, in the usual manner, a decided precipitate of ammonio-phosphate of magnesium; the water sold as distilled cherry laurel water appears to have been made from the volatile oil by triturating it with magnesia and water.

A specimen of *ceratum plumbi subacetatis* was shown, and, in a note from Mr. Andrew Blair, it was stated that if the solution of basic acetate were added to the melted fatty matters when barely fluid, the preparation would keep well, and not change color.

A paper upon bacteria, by A. B. Stewart, Ph.G., was read and referred to the publication committee.

A paper upon *phénol sodique* was read, showing that the solution made according to the formula published in the *National Formulary* was much too strong to be used in the manner directed for the commercial phenol sodique. Mr. McIntyre said that a judicious name for this preparation was wanted. Dr. Lowe said it was a good dressing for wounds, promoting healing by first intention.

Mr. Beringer read a paper upon tincture of musk, contrasting the strength with that of the German pharmacopœia, and recommending diluted alcohol as a menstruum.

Prof. Maisch exhibited a number of very handsome and instructive botanical models, made by Robert Brendel, of Berlin, Germany, and imported by him last fall for illustrating his lectures. These models are made on a larger scale than those which he had used for the last fifteen years, and which had been made by the same firm. The models comprise flowers of nuphar, polygala, centaurea, taraxacum, sambucus, salvia, hyoscyamus, ricinus, humulus, juniperus, and others; also, the yeast plant in various stages of development, a number of fungi, and transverse sections of six ovaries, showing the internal structure.—*Am. Jour. Pharm.*

BAKING POWDERS.

R. T. WHEELER, in *Science*, details numerous experiments made with a view to ascertaining the influence of baking powder residues on digestion, and as a summary of the facts brought out by the investigation, finds:

1. That the residues of all baking powders, no matter how pure may be their constituents, have a harmful effect upon digestion, due in all probability primarily to the fact that the salts are acted upon by the hydrochloric acid of the gastric juice with the formation of more soluble compounds, and secondarily, that these salts may form organic compounds with albuminous bodies in the same manner as many of the metals do. 2. That calcium phosphate, on account of its great inhibitory action on digestion, must be regarded as a poor agent for the manufacture of a baking powder, while ammonium tartrate may be looked upon with more favor. 3. That the presence of alum in a powder made with calcium phosphate greatly increases its retarding action. 4. That the least harmful baking powder is one containing only the bicarbonate of soda and cream of tartar, and that the presence of any other chemical substance, however harmless it may be in itself, tends only to increase the complexity of the residue and impair the activity of the gastric juice.

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